Foreword

The Soil Survey of Pierce County Area, Washington, contains much information useful in any land-planning program. Of prime importance are the predictions of soil behavior for selected land uses. Also highlighted are limitations or hazards to land uses that are inherent in the soil, improvements needed to overcome these limitations, and the impact that selected land uses will have on the environment.

This soil survey has been prepared for many different users. Farmers, ranchers, foresters, and agronomists can use it to determine the potential of the soil and the management practices required for food and fiber production. Planners, community officials, engineers, developers, builders, and homebuyers can use it to plan land use, select sites for construction, develop soil resources, or identify any special practices that may be needed to insure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the soil survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur even within short distances. Soils may be seasonally wet or subject to flooding. They may be shallow to bedrock. They may be too unstable to be used as a foundation for buildings or roads. Very clayey or we; soils are poorly suited to septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map; the location of each kind of soil is shown on detailed soil maps. Each kind of soil in the survey area is described, and much information is given about each soil for specific uses. Additional information or assistance in using this publication can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

This soil survey can be useful in the conservation, development, and productive use of soil, water, and other resources.

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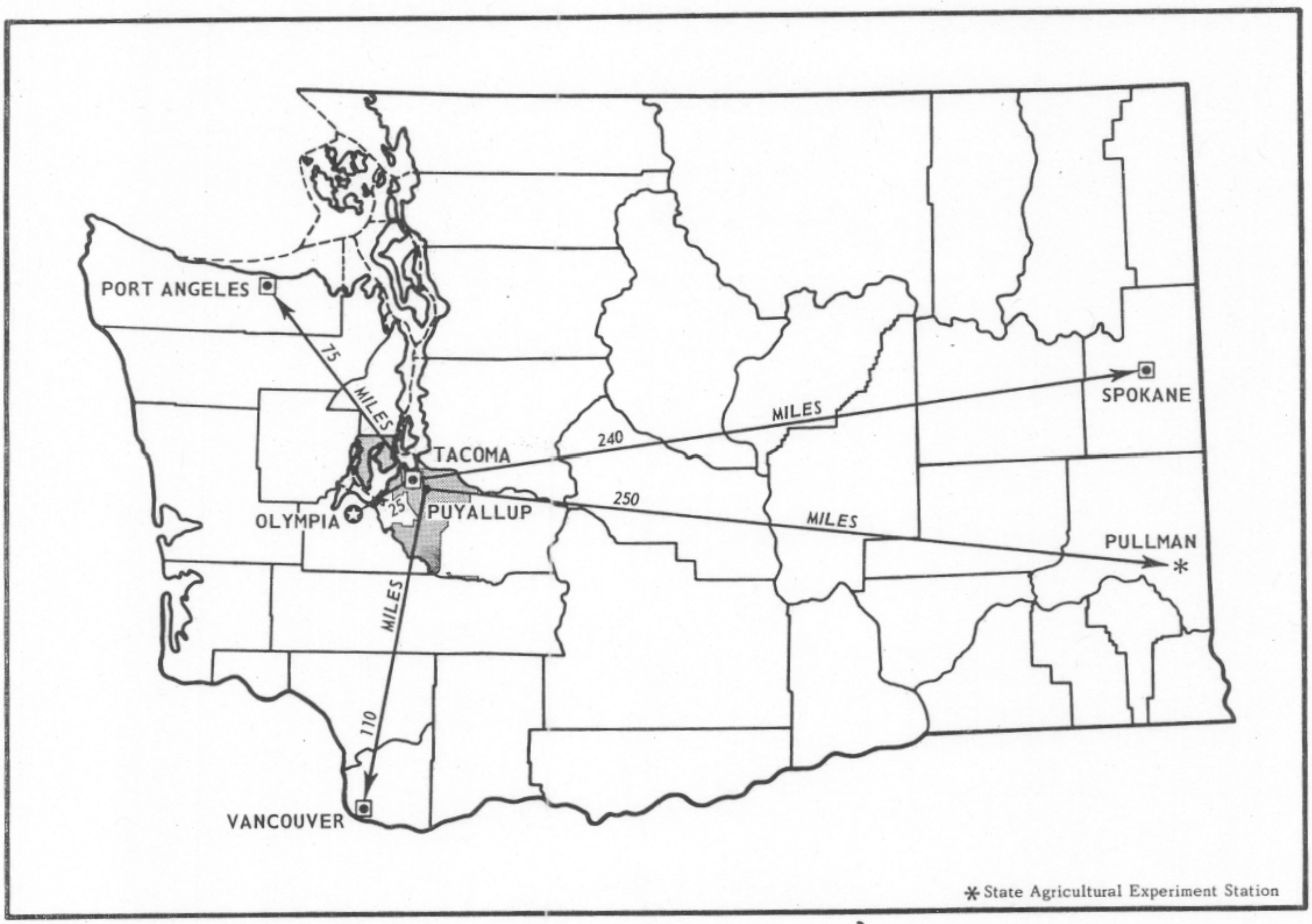

Location of Pierce County Area in Washington.

SOIL SURVEY OF PIERCE COUNTY AREA, WASHINGTON

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PIERCE COUNTY AREA is adjacent to Puget Sound in the western part of Washington (see map on facing page). It covers 389,967 acres, or about 609 square miles. The elevation of the Area ranges from sea level to about 2,000 feet. The Area consists of nearly level plains, rolling uplands, and steep foothills. Nearly level flood plains and low terraces dominate the river valleys. Two major rivers, the Nisqually and Puyallup, flow through the area and into Puget Sound. Major tributaries of the Puyallup River include the Carbon and White Rivers. Each of these four rivers has its source at glaciers on Mt. Rainier.

Once a largely rural area that had farming and lumbering as the principal industries, Pierce County Area has experienced rapid growth and development and a subsequent demand for residential, business, and industrial sites. Between 1958 and 1967, according to the Washington Soil and Water Conservation Needs Inventory, forests and croplands in Pierce County were converted to other uses at a rate of about 5,000 acres annually.

The soils of the Area have been important to the growth and development of Pierce County Area. Since 1870, the fertile floodplains and low terraces of the Puyallup and White River valleys have been intensively farmed. The harvesting and processing of flower bulbs, vegetables, cane fruits, and other crops for local and foreign markets have been and continue to be a source of employment for many people who live in the surrounding communities (fig. 1). According to the Pierce County Rural Manpower Service, in June 1974 more than 6,000 people were employed harvesting crops. To assist the agricultural industry in western Washington, Washington State University maintains a research and extension center at Puyallup.

The soils of the uplands formed mainly in debris deposited during the Pleistocene glaciation more than 15,000 years ago. The soils around Buckley Armed in the Osceola mudflow, which was deposited about 4,800 years ago (3, 4). Less intensively farmed, these soils are used mainly for hay and pasture for dairy and beef cattle.

Recent urban development has centered initially upon soils with the fewest limitations for such use. For example, those soils that are nearly level to rolling and have good drainage, such as those in the Lakewood area, have become highly urbanized. Douglas-fir is a dominant species on the upland soils, which support mixed conifers and hardwoods. Increased urban pressures have resulted in a shift of highly intensive woodland management from the uplands to the foothills and southern portions of the Area.

How this survey was made

Soil scientists made this survey to learn what kinds of soil are in the survey area, where they are, and how they can be used. The soil scientists went into the area knowing they likely would locate many soils they already knew something about and perhaps identify some they had never seen before. They observed the steepness, length, and shape of slopes; the size of streams and the general pattern of drainage; the kinds of native plants or crops; the kinds of rock; and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material, which has been changed very little by leaching or by the action of plant roots.

The soil scientists recorded the characteristics of the profiles they studied, and they compared those profiles with others in counties nearby and in places more distant. Thus, through correlation, they classified and named the soils according to nationwide, uniform procedures.

After a guide for classifying and naming the soils was worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodlands, buildings, field borders, roads, and other details that help in drawing boundaries accurately. The soil map at the back of this publication was prepared from aerial photographs.

The areas shown on a soil map are called soil map units. Some map units are made up of one kind of soil, others are made up of two or more kinds of soil, and a few have little or no soil material at all. Map units are discussed in the sections "General soil map for broad land use planning" and "Soil maps for detailed planning."

While a soil survey is in progress, samples of soils are taken as needed for laboratory measurements and for engineering tests. The soils are field tested, and interpretations of their behavior are modified as necessary during the course of the survey. New interpretations are added to meet local needs, mainly through field observations of different kinds of soil in different uses under different levels of management. Also, data are assembled from other sources, such as test results, records, field experience, and information available from State and local specialists. For example, data on crop yields under defined practices are assembled from farm records and from field or plot experiments on the same kinds of soil.

But only part of a soil survey is done when the soils have been named, described, interpreted, and delineated on aerial photographs and when the laboratory data and other data have been assembled. The mass of detailed information then needs to be organized so that it is readily available to different groups of users, among them farmers, managers of rangeland and woodland, engineers, planners, developers and builders, homebuyers, and those seeking recreation.

General soil map for broad land use planning

The general soil map at the back of this publication shows, in color, associations that have a distinct pattern of soils and of relief and drainage. Each association is a unique natural landscape. Typically, an association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in other associations but in a different pattern.

The general soil map provides a broad perspective of the soils and landscapes in the survey area. It provides a basis for comparing the potential of large areas for general kinds of land use. Areas that are, for the most part, suited to certain kinds of farming or to other land uses can be identified on the map. Likewise, areas of soils having properties that are distinctly unfavorable for certain land uses can be located.

Because of its small scale, the map does not show the kind of soil at a specific site. Thus, it is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The kinds of soil in any one map unit differ from place to place in slope, depth, stoniness, drainage, or other characteristics that affect their management.

Broad land use considerations

Deciding which land should be used for urban development is an important consideration in the survey area. Each year a considerable amount of land is being developed for urban uses in Puyallup, Buckley, Steilacoom, and other cities in the Area. It is estimated that about 76,000 acres, or nearly one-fifth of the survey area, is urban or built-up land. The general soil map is helpful for planning the general outline for urban areas; it cannot be used for the selection of sites for specific urban structures. In general in the survey area the soils that have good potential for cultivated crops also have good potential for urban development. The data about specific soils in this survey can be helpful in planning future land use patterns.

Large portions of the Puyallup-Sultan association are flood plains in which flooding and ponding are severe limitations. Also, urban development is very costly on the soft, wet organic soils in the Kapowsin and PuyallupSultan associations and on the steep, unstable soils of the Harstine and Alderwood-Everett associations. Many parts of the Barneston-Scamman-Wilkeson association are steep and very steep soils on which urban development is difficult. The slowly permeable soils of the Buckley association have poor potential for urban development because of wetness.

In large areas of the Area are soils that are suitable for urban uses. These include parts of the Puyallup-Sultan association that are not on flood plains, the Spanaway association, and the less sloping portions of the AlderwoodEverett and the Harstine associations. The part of the Puyallup-Sultan association that is not on flood plains is excellent farmland, and this potential should not be overlooked when broad land uses are considered.

In some parts of the survey area there are soils that have good potential for farming but fair or poor potential for nonfarm uses. These are identified as associations 1, 5, and 7 on the general soil map. In these soil associations the dominant soils are Puyallup, Sultan, Kapowsin, and Buckley soils. Wetness and flooding are limitations to the nonfarm uses of these soils. With proper drainage and shaping of the surface and diking, these limitations can be overcome. These soils have good potential for farming and many farmers have provided sufficient drainage for farm crops.

Vegetables and other specialty crops are uniquely suited to soils of the Puyallup-Sultan association where a suitable drainage system has been installed. Also good for dairy farming are soils of the Buckley association and less sloping portions of the Kapowsin association.

Most of the soils of the survey area have good or fair potential for woodland. Notable exceptions are the soils of the Spanaway association on which commercially valuable trees are less common and generally do not grow so rapidly.

The rolling Barneston-Scamman-Wilkeson association and the nearly level Spanaway association have excellent potential as sites for parks and extensive recreation areas. Forests enhance the beauty of much of these areas. Undrained marshes and swamps of the Kapowsin and the Puyallup-Sultan associations are good for nature study. All soils in the survey area provide habitat for many species of wildlife.

Descriptions of soil associations

1. Kapowsin association

Undulating to rolling, moderately well drained soils that formed in glacial till; on uplands

The Kapowsin association consists of undulating to rolling uplands in the south-central part of the survey area. It covers a wide area from Graham south to Eatonville. A smaller portion is in the Midland area east of Parkland. Drainage channels are not well expressed, and as a result ponding is common during winter. Several creeks with little or no floodplain drain most of the association. Muck, South, and Tanwax Creeks are most prominent. Ohop Creeks, which has a fairly wide floodplain, drains Ohop Lake at its southern end. All these streams except South Creek empty into the Nisqually River. Clear and Swan Creek, as well as a part of Clover Creek, drain the Midland area. Kapowsin and Ohop Lakes border the eastern edge of this association. Smaller lakes dot the landscape north and west of Eatonville. Elevation ranges from 300 to 900 feet. The annual precipitation is 35 to 45 inches. Mean annual air temperature is about 50 degrees F, and the average frost-free season is about 1.80 days. The native vegetation is conifers.

This association makes up about 33 percent of the survey area. Kapowsin soils occupy about 46 percent, Alderwood and Everett soils 20 percent, and Dupont, McKenna, Tisch, and other soils the remaining 34 percent of this association (fig. 2).

Kapowsin soils are moderately well drained. These soils have a faintly mottled subsoil and a weakly cemented, very slowly permeable substratum at a depth of about 2 feet. Slopes are mainly 0 to 15 percent but range to 70 percent.

This association is used for farming, woodland, urban development, recreation, and wetland wildlife habitat. Kapowsin soils are used for dairy farming and for raising beef cattle. Hay and pasture are the main crops. These soils are moderately fertile and have low to moderate available water capacity. Crop yields are good. Large areas are in second or third growth Douglas-fir or red alder. Community sewerage systems are necessary in areas of moderate to high population density. Lakes and streams offer excellent fishing and other recreational activities.

Full-time farms in the area average about 270 acres in size.

2. Harstine association

Nearly level to rolling, moderately well drained soils that formed in glacial till; on uplands

The Harstine association consists of nearly level to rolling uplands. It dominates the Gig Harbor and Longbranch peninsulas and the islands in the western part of the survey area. The uplands are broken by moderately steep to steep slopes along drainage channels. In addition, very steep slopes break abruptly along the edges of this association straight into Puget Sound. Numerous small streams drain the uplands. Wet spots of 1 to 3 acres in size are common. Bay, Crescent, Florence, and Josephine Lakes are the largest bodies of fresh water. Elevation ranges from sea level to about 400 feet. The annual precipitation is 35 to 50 inches. Mean annual air temperature is about 50 degrees F, and the average frost-free season is about 180 days. The native vegetation is conifers.

This association makes up about 19 percent of the survey area. Harstine soils occupy about 62 percent of this association, Indianola, Bow, Kitsap, and Neilton soils 23 percent, and other soils 15 percent (fig. 3).

Harstine soils are moderately well drained. They have a weakly cemented, very slowly permeable layer at a depth of 2 to 3 feet. Slopes are dominantly rolling.

This association is used for woodland, urban development, and farming. Most of the woodland is second or third growth Douglas-fir. Brush picking is a minor industry. Evergreen huckleberry, swordfern, and salal are the main species. The shift in population from urban to rural areas has resulted in a change to greater year-round residential use of this association. Where this association is cultivated, hay and pasture are the chief crops and yields are fair to good.

Farms in this association are operated on a part-time basis.

3. Alderwood-Everett association

Nearly level to rolling, moderately well drained and somewhat excessively drained soils that formed in glacial till and glacial outwash; on uplands

This association consists of nearly level to rolling uplands, mainly in the northern part of the survey area. Long, steep or very steep slopes break abruptly along the edges of these uplands into drainage channels or directly to the valley floor. Fennel Creek is the only perennial stream. Seasonal ponding of water in low areas is common. Much of Lake Tapps and the North Hill and South Hill areas of Puyallup is in this association. Several lakes are in the association; the largest is Lake Tapps. Elevation ranges from 20 to 800 feet. The mean annual precipitation is 35 to 45 inches. Mean annual air temperature is 50 degrees F, and the average frost-free season is about 180 days. The native vegetation is conifers.

This association makes up about 16 percent of the survey area. Alderwood soils make up about 32 percent of the association, Everett soils 22 percent, and Kapowsin, Indianola, and Kitsap soils 14 percent. Small amounts of other soils make up the remaining 32 percent (fig. 4).

Alderwood soils are moderately well drained. The substratum is weakly cemented and very slowly permeable, beginning at a depth of about 3 feet. Slopes are dominantly 0 to 15 percent but range to 30 percent. They are convex.

Everett soils are somewhat excessively drained. They have a gravelly sandy loam subsoil and, at a depth of about 2 feet, a loose gravelly sand substratum. Slopes are nearly level. In places these slopes are broken by short, steep terrace breaks.

This association is used mainly for homesites. It is well suited for industrial sites. Large tracts are still under native vegetation, but they are rapidly being urbanized. This association ranks among the less desirable for farming but among the most desirable as a source of sand and gravel for construction purposes. It is suited to pasture and timber or Christmas tree production. Small acreages of cane fruit are grown.

Most residential use is directed toward moderate to high density levels. Onsite sewerage disposal systems are suited to as much as one-third of this association.

4. Spanaway association

Nearly level, somewhat excessively drained soils that formed in glacial outwash; on uplands

This association consists of nearly level uplands in the western part of the survey area. The communities of Lakewood, Parkland, Spanaway, and Roy are located within this association. Clover and Chambers Creeks drain the northern part of this association, and Muck Creek drains the southern part. Elevations ranges from 200 to 500 feet. The annual precipitation is 35 to 45 inches. Mean annual temperature is about 51 degrees F, and the average frost-free season is about 180 days. The native vegetation is grass, conifers, and hardwood.

This association makes up about 11 percent of the survey area. Spanaway soils make up 67 percent of this association, Everett soils 10 percent, Spana soils 3 percent, Nisqually soils 3 percent, and smaller amounts of other soils 17 percent (fig. 5).

Spanaway soils are somewhat excessively drained and have a thick, dark-colored surface layer.

The Spanaway association is used for urban development, woodland, and native grazing land. It is a good source of gravel for construction purposes. Parts of the association, particularly the northern section, are highly urbanized. Where used for farmland, this association is better suited to grass than to row crops.

Most of the urban population in this association is centered around the communities of Lakewood, Parkland, and Spanaway.

5. Puyallup-Sultan association

Nearly level, well drained and moderately well drained soils that formed in alluvium; on flood plains

This association consists of nearly level floodplains of the Puyallup, Stock, and Nisqually Rivers. The towns of Puyallup, Sumner, Fife, and Orting are located within this association. Elevation ranges from sea level to 600 feet. The annual precipitation is 35 to 50 inches. Mean annual air temperature is 50 degrees F, and the average frost free season is about 190 days. The native vegetation is conifers and hardwoods.

This association makes up about 7 percent of the survey area. Puyallup soils occupy 27 percent of the association, Sultan soils 17 percent, Orting soils 12 percent, Pilchuck soils 12 percent, and Briscot soils 10 percent. Lesser amounts of Snohomish, Xerorthents, Aquic Xerofluvents, Semiahmoo, Riverwash, Puget, and Shalcar soils make up the remaining 22 percent (fig. 6).

Puyallup soils are well drained. They are fine sandy loam and, at a depth of about 30 inches, fine sand. Sultan soils are moderately well drained. They are stratified silty clay loam, silt loam, fine sandy loam, and fine sand.

This association is used for farming and for home and industrial sites. Most specialty crops are shipped to local urban centers. Lettuce, rhubarb, caneberries, bulbs, and flowers are common crops. Most of the soils in this association lack the natural ability to support heavy loads. Adjacent soils on uplands are a good source for fill material.

Full-time farms in this association average about 65 acres in size.

6. Barneston-Scamman-Wilkeson association

Nearly level to very steep, somewhat excessively drained to somewhat poorly drained soils that formed in glacial till, glacial outwash, and residuum from bedrock; on uplands

This association consists of nearly level to rolling terraces and hilly uplands in the eastern part of the survey area. Steep and very steep slopes break into drainage channels that carry melt waters from Mt. Rainier. The communities of Wilkeson, Carbonado, Elbe, and Ashford are in this association. Elevation ranges from 500 to 2,000 feet. The annual precipitation is 50 to 80 inches. Mean annual temperature is about 49 degrees F, and the average frost-free season is about 155 days. The native vegetation is conifers.

This association makes up about 10 percent of the survey. Barneston soils occupy 27 percent of this association, Scamman soils 22 percent, Wilkeson soils 11 percent, National soils 8 percent, and Cinebar soils 3 percent. The remaining 29 percent consists of Aquic Xerofluvents, Greenwater and Pilchuck soils, and Rock outcrop (fig. 7).

Barneston soils are somewhat excessively drained. They are mainly nearly level to undulating or rolling glacial outwash terraces at low elevations, and they are gravelly coarse sandy loam and very gravelly sand to a depth of more than 5 feet. Scamman soils formed in clayey glacial till and are mainly moderately steep and steep on uplands at somewhat higher elevations. They are somewhat poorly drained, slowly permeable, and clayey. Wilkeson soils formed in weathered andesite and basalt and are mainly steep and very steep on the sides of the higher foothills of the Cascades. They are well drained, are moderately permeable, and have a profile dominantly of gravelly silt loam and gravelly silty clay loam.

Much of this association is managed for woodland. Most of it has been logged and supports second growth forests. Where the soils have been cleared of trees, hay and pasture are the chief crops. Recreational use of noncultivated land is increasing, particularly along the highway to Mt. Rainier National Park. This association is used for watersheds and wildlife habitat. Deer, elk, and bear are hunted.

Very few farms in this association are operated on a full-time basis.

7. Buckley association

Nearly level, poorly drained soils that formed in the Osceola mudflow; on uplands

This association consists of dominantly nearly level upland plains in the northeastern part of the survey area. The communities of Buckley and South Prairie are in this association. Elevation ranges from 500 to 800 feet. The annual precipitation is 45 to 55 inches. Mean annual air temperature is about 50 degrees F, and the average frost-free season is about 190 days. The native vegetation is conifers and hardwoods.

This association makes up only 4 percent of the survey. Buckley soils make up 69 percent of the association, Alderwood soils 13 percent, Indianola soils 7 percent, and minor amounts of other soils the remaining 11 percent (fig. 8).

Buckley soils are poorly drained and nearly level. They have a very dark brown loam surface layer and a mottled, slowly permeable gravelly sandy loam and gravelly sandy clay loam subsoil.

This association is used for farming and residential development. Most of the farms are dairy. Hay, pasture, and small grain are the dominant crops. Corn for silage is a minor crop. Crop yields are good. Water ponds for very long periods in Buckley soils. Drainage is by tile or open ditch methods if outlets are available. The drier soils are used for building sites. Community sewerage facilities are necessary in this association.

Full-time farms in this association average about 80 acres in size.

Soil maps for detailed planning

The map units shown on the detailed soil maps at the back of this publication represent the kinds of soil in the survey area. They are described in this section. The descriptions together with the soil maps can be useful in determining the potential of a soil and in managing it for food and fiber production; in planning land use and developing soil resources; and in enhancing, protecting, and preserving the environment. More information for each map unit, or soil, is given in the section "Use and management of the soils."

Preceding the name of each map unit is the symbol that identifies the soil on the detailed soil maps. Each soil description includes general facts about the soil and a brief description of the soil profile. In each description, the principal hazards and limitations are indicated, and the management concerns and practices needed are discussed.

The map units on the detailed soil maps represent an area on the landscape made up mostly of the soil or soils for which the unit is named. Most of the delineations shown on the detailed soil map are phases of soil series.

Soils that have profiles that are almost alike make up a *soil series.* Except for allowable differences in texture of the surface layer or of the underlying substratum, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement in the profile. A soil series commonly is named for a town or geographic feature near the place where a soil of that series was first observed and mapped.

Soils of one series can differ in texture of the surface layer or the underlying substratum and in slope, erosion, stoniness, salinity, wetness, or other characteristics that affect their use. On the basis of such differences, a soil series is divided into phases. The name of a *soil phase* commonly indicates a feature that affects use or management. For example, Barneston gravelly coarse sandy loam, 0 to 6 percent slopes, is one of several phases within the Barneston series.

Some map units are made up of two or more dominant kinds of soil. Such map units are called soil complexes.

A *soil complex* consists of areas of two or more soils that are so intricately mixed or so small in size that they cannot be shown separately on the soil map. Each area includes some of each of the two or more dominant soils, and the pattern and proportion are somewhat similar in all areas. Kitsap-Indianola complex, 45 to 70 percent slopes, is an example.

Most map units include small, scattered areas of soils other than those that appear in the name of the map unit. Some of these soils have properties that differ substantially from those of the dominant soil or soils and thus could significantly affect use and management of the map unit. These soils are described in the description of each map unit. Some of the more unusual or strongly contrasting soils that are included are identified by a special symbol on the soil map.

Most mapped areas include places that have little or no soil material and support little or no vegetation. Such places are called *miscellaneous areas;* they are delineated on the soil map and given descriptive names. Rock outcrop is an example. Some of these areas are too small to be delineated and are identified by a special symbol on the soil map.

The acreage and proportionate extent of each map unit are given in table 1, and additional information on properties, limitations, capabilities, and potentials for many soil uses is given for each kind of soil in other tables in this survey. Many of the terms used in describing soils are defined in the Glossary.

1B-Alderwood gravelly sandy loam, 0 to 6 percent slopes. This nearly level to undulating soil is moderately well drained. It formed in glacial till and is one of the most extensive soils on the broad uplands in the central part of the county. Vegetation is hardwoods arid conifers. Elevation ranges from 200 to 800 feet. The mean annual precipitation is about 35 inches, the mean annual air temperature is about 50 degrees F, and the frost-free season averages about 180 days. Individual soil areas average about 100 acres in size and 4 percent in slope. Granite boulders and stones are strewn across some slopes.

Included with this soil in mapping in some areas are as much as 10 percent poorly drained Bellingham and Norma soils and very poorly drained Dupont soils; other areas are as much as 5 percent Everett soils.

In a typical profile, a thin mat of undecomposed needles and wood fragments overlies a 1 1/2-inch, very dark grayish brown gravelly sandy loam surface layer. The subsoil and the upper part of the substratum, to a depth of 38 inches, are dark yellowish brown, brown, and dark grayish brown gravelly sandy loam. The lower part of the substratum, to a depth of more than 60 inches is weakly cemented, compact glacial till (fig. 9). Reaction is medium acid.

A perched water table develops for short periods during the winter and spring rainy seasons. Permeability is very slow in the weakly cemented, compact part of the substratum. Commonly root growth is inhibited and roots are matted directly above this layer. The available water capacity is low. Surface runoff is very slow to slow, and the erosion hazard is slight.

Although much of the acreage is cultivated or is in woodland, urban development is rapidly replacing agricultural uses in the urban-rural fringe areas. Hay and pasture are the chief crops. Strawberries and cane fruit, principally raspberries, are the minor crops. The weakly cemented substratum limits suitability of deep rooted crops.

The organic matter content can be maintained by using all crop residue, plowing under cover crops, and using suitable cropping systems. A typical cropping; system includes a pasture of orchardgrass and white clover for 5 or 6 years followed by oats for 1 year or strawberries for 3 years.

Most crops respond to nitrogen, phosphorus, and potassium. Legumes benefit from applications of agricultural lime. Fertilizer needs are best determined by a soil test.

This Alderwood soil is suited for the production of Douglas-fir. It is capable of producing annually 155 cubic feet (CMAI), or 700 board feet (Scribner rule), per acre. In places, plant competition prevents adequate restocking, either natural or artificial, without proper site preparation. During periods of heavy rainfall the perched water table may be at a shallow depth and will restrict the use of ground equipment. Windthrown trees are common.

The increase in population and the movement of people from urban to rural areas have resulted in greater residential use of this Alderwood soil. Homesite excavation is limited by the weakly cemented and compact substratum. In areas of moderate to high population, on-site sewage disposal systems often fail or do not function properly during periods of high rainfall because of this restrictive layer. This soil has a natural ability to support large loads. Capability subclass IVs.

1C-Alderwood gravelly sandy loam, 6 to 15 percent slopes. This rolling Alderwood soil is moderately well drained. It formed in glacial till on broad uplands. It is extensive in the Lake Tapps area. Vegetation is hardwoods and conifers. Elevation ranges from 200 to 800 feet. The mean annual precipitation is about 35 inches, mean annual air temperature is about 50 degrees F, and the frost-free season averages about 180 days. Individual soil areas average about 125 acres in size. Most slopes average about 8 percent. Granite boulders and stones are strewn across some slopes.

Included with this soil in mapping are small areas of better drained Indianola loamy sand on side slopes and poorer drained Norma sandy loam or Dupont muck in troughs. In addition, some areas of Alderwood gravelly sandy loam and Kapowsin gravelly loam, 0 to 6 percent slopes, are included.

In a typical soil profile, a mat of undecomposed needles and wood fragments rests upon a 1 1/2-inch-thick very dark grayish brown gravelly sandy loam surface layer. The subsoil and the upper part of the substratum, to a depth of 38 inches, are dark yellowish brown, brown, and dark grayish brown gravelly sandy loam. The lower part of the substratum, to a depth of more than 60 inches, is weakly cemented compact glacial till. Reaction is medium acid.

The water table is perched above the very slowly permeable, weakly cemented and compact part of the substratum during periods of heavy rainfall. However, the perched water table is of short duration because water flows laterally above this layer to seeps at the bottom of slopes. Very few roots penetrate this dense substratum. The available water capacity is low. Surface runoff is medium, and the erosion hazard is moderate.

Although much of the acreage is cultivated or wooded, urban development, particularly residential subdivision, is rapidly replacing these uses in the urban-rural fringe areas. Hay and pasture are the chief crops. Strawberries and cane fruit, principally raspberries, are the minor crops. The dense substratum limits the suitability of deep rooted crops.

Under good management this Alderwood soil is moderately productive. Practices that reduce soil erosion and maintain tilth and fertility are necessary. Proper grazing, weed control, and supplemental irrigation help to maximize forage yields.

The organic matter content can be maintained by using all crop residue, plowing under cover crops, and using suitable cropping systems. For example, 5 or 6 years of orchardgrass and white clover for hay or pasture and 1 year of oats or 3 years of strawberries is a suitable cropping system.

Most crops respond to applications o: nitrogen, phosphorus, and potassium fertilizers. Legumes benefit from applications of agricultural lime.

This Alderwood soil is suited for the production of Douglas-fir. It is capable of producing annually 155 cubic feet (CMAI), or 700 board feet (Scribner rule), per acre. This soil has few limitations except plant competition, which prevents adequate restocking, either natural or artificial, without proper site preparation. Except for some matting of roots because of the dense substratum, root growth is normal. Windthrown trees are common.

Because of its proximity to urban centers, this Alderwood soil is subject to urbanization pressure. The soil has an inherent ability to support a large load. Soil slope and the weakly cemented, compact substratum are its limiting features. In areas of moderate to high population density, onsite sewage disposal systems often fail or do not function properly during periods of rainfall in winter. Excavation for basements and utility lines is difficult. Topsoil needs to be stockpiled and subsequently used to cover excavated soil material. Capability subclass IVe.

1D-Alderwood gravelly sandy loam, 15 to 30 percent slopes. This moderately steep Alderwood soil is moderately well drained. It formed in glacial till on the broad uplands. Vegetation is hardwoods and conifers. Elevation ranges from 200 to 800 feet. The mean annual precipitation is about 35 inches, the mean annual air temperature is about 50 degrees F, and the frost-free season averages about 180 days. Individual soil areas are long and narrow and are along drainageways. Most slopes average about 18 percent.

Included with this soil in mapping on the lower portions of slopes are small areas of Everett gravelly sandy loam, Indianola loamy sand, and Ragnar sandy loam.

In a typical soil profile, a mat of undecomposed needles and wood rests upon a 1 1/2-inch-thick very dark grayish brown gravelly sandy loam surface layer. The subsoil and the upper part of the substratum, to a depth of 40 inches, are dark yellowish brown, brown, and dark grayish brown gravelly sandy loam. The lower part of the substratum, to a depth of more than 60 inches, is weakly cemented, compact glacial till. Reaction is medium acid.

Water is perched above the very slowly permeable, weakly cemented, compact part of the substratum only for short periods. It flows on top of this dense layer to seeps on the lower portions of these moderately steep slopes. Very few roots enter this layer except through cracks. The available water capacity is low. Surface runoff is medium to rapid, and the erosion hazard is moderate to severe.

Most of the acreage is woodland. The rest is in wild pasture and urban uses.

This soil is suited for the production of Douglas-fir. A fully stocked, even-aged stand is capable of producing annually 155 cubic feet (CMAI), or 700 board feet (Scribner rule), per acre. Plant competition prevents adequate restocking, either natural or artificial, without proper site preparation. Windthrown trees are common. Conventional methods can be used for tree harvest but may be limited during rainy periods. Soil losses are minimized by use of special erosion control practices.

This Alderwood soil is limited for homesites because of the moderately steep slopes. Excavation involves ripping the weakly cemented, compact substratum. The topsoil needs to be stockpiled and subsequently used to cover excavated soil material. A site preparation system that controls runoff and maintains the esthetic value is needed. During the winter and spring rainy season, septic water from onsite sewage disposal units may seep at points farther down the slope. Capability subclass VIe.

2A-Aquic Xerofluvents, level. These soils are somewhat excessively drained to poorly drained. They formed in unconsolidated alluvium along major and minor streams throughout the survey area. Slopes are 0 to 2 percent. Vegetation is deciduous and coniferous trees. The mean annual precipitation is 25 to 90 inches. The annual temperature ranges from 47 to 53 degrees F, and the annual growing season ranges from 160 to 200 days.

Included with this unit in mapping are small areas of Pilchuck fine sand and Riverwash.

No one profile represents this unit, but one of the more common ones has a surface layer of very dark grayish brown silt loam to a depth of 10 inches. The underlying material to a depth of 32 inches is very dark grayish brown fine sandy loam, loamy fine sand, and silt loam; to a depth of 60 inches it is dark gray and dark grayish brown loamy fine sand and gravelly sand. Reaction is neutral.

Aquic Xerofluvents are used mostly for woodland and wildlife habitat. Along major streams, these soils are protected from periodic overflow by levees. In places they are used for wild pasture and recreation homesites. Red alder, black cottonwood, Douglas-fir, and western redcedar are dominant trees.

Where these soils are cultivated, grasses and legumes need to be established as a permanent cover crop. Orchardgrass and white clover are suitable for pasture. Mowing controls weeds. A suitable rotational grazing system produces more forage than continuous grazing. Eliminating grazing in late fall allows for sufficient regrowth.

The primary limitations for timber production and urban development on these soils are a high water table and the frequent flooding from runoff in winter and spring. Water accumulates behind levees as a result of runoff from nearby higher areas or as a result of seepage beneath levees during periods of high streamflow. Some windthrown trees may be expected because of restricted rooting depth. Capability subclass VIw.

3B-Barneston gravelly coarse sandy loam, 0 to 6 percent slopes. This nearly level to undulating Barneston soil is somewhat excessively drained. It formed in gravelly glacial outwash under conifers along the foothills of the Cascades. Elevation ranges from 500 to 1,200 feet. The annual precipitation is 45 to 70 inches, mean annual air temperature is about 49 degrees F, and the frost-free season averages about 155 days. Areas range from 6 acres to more than 500 acres in size, but most are about 100 acres.

Included with this soil in mapping are as much as 5 percent sandy Indianola soils and as much as 15 percent soils that are stony and rolling.

In a typical profile a mat of extremely acid, undecomposed needles and wood overlies a 5-inch, very dark brown and very dark grayish brown, very strongly acid or extremely acid gravelly coarse sandy loam surface layer. The subsoil, to a depth of 13 inches, is dark yellowish brown, strongly acid gravelly coarse sandy loam. The substratum, to a depth of more than 60 inches, is brown, medium acid very gravelly sand.

Permeability is rapid. The available water capacity is low. Surface runoff is very slow to slow, and there is no erosion hazard. Few roots grow into the substratum.

Most of the area of this soil is in woodland. Some areas are used for pasture.

This soil is suited to the production of Douglas-fir. It is capable of producing annually 135 cubic feet (CMAI), or 560 board feet (Scribner rule), per acre. Tree harvest by conventional methods is feasible anytime during the year. Hand planting of Douglas-fir helps to establish a more uniform stand than natural seeding, but the gravel content hampers hand planting.

This soil is not in highly populated areas, and urban development pressure is minimal. Septic tank drainage fields function properly throughout the year in these areas; however, because the soil is very permeable, there is a potential of polluting underground water or nearby streams. The soil is a good source of roadfill, and the forested areas provide habitat for black-tailed deer.

Where the areas are cleared and good management practices are used, this soil is fairly productive. Practices that maintain tilth and fertility are needed. Prevention of overgrazing, weed control, and supplemental irrigation help to maximize forage yields.

A good cropping system on this soil includes a pasture of orchardgrass and white clover for 5 or 6 years followed by oats for 1 year. Most crops respond to nitrogen, phosphorus, and potassium. Legumes benefit from applications of agricultural lime. Capability subclass IVs.

3C-Barneston gravelly coarse sandy loam, 6 to 15 percent slopes. This rolling soil is somewhat excessively drained. It formed in gravelly glacial outwash under conifers along the foothills of the Cascades. Slopes are short. Elevation ranges from 500 to 1,200 feet. The annual precipitation is 45 to 70 inches, mean annual air temperature is about 49 degrees F, and the frost-free season averages about 155 days. Areas average about 250 acres in size.

Included with this soil in mapping are as much as 7 percent sandy Indianola soils, as much as 10 percent soils that are underlain by shattered andesite at a depth of about 1 to 3 feet, and 5 percent stony soils that are undulating.

In a typical profile a mat of extremely acid undecomposed needles and wood overlies a 5-inch, very dark brown and very dark grayish brown, very strongly acid gravelly coarse sandy loam surface layer. The subsoil, to a depth of 13 inches, is dark yellowish brown, strongly acid gravelly coarse sandy loam. The substratum, to a depth of more than 60 inches, is brown, medium acid very gravelly sand (fig. 10).

Permeability is rapid. The available water capacity is low. Surface runoff is slow, and there is a slight erosion hazard. Few roots grow into the substratum.

Most of the acreage of this soil is woodland. Some areas are used for pasture.

This Barneston soil is suited to the production of Douglas-fir. It is capable of producing annually 135 cubic feet (CMAI), or 560 board feet (Scribner rule), per acre. Tree harvest by conventional methods is feasible anytime during the year. Hand planting of Douglas-fir helps to establish a more uniform stand than natural seeding, but the gravel content hampers hand planting. Seedling survival is very low where depressions allow frost pockets to develop.

This soil is not near highly populated areas, and urban development pressure is minimal. Septic tank drainage fields function properly throughout the year in these areas; however, because the soil is very permeable, there is a potential of polluting underground water or nearby streams. The soil is a good source of roadfill. Cuts and fills are common. Forested areas provide habitat for black-tailed deer. Where the areas are cleared and good management practices are used, this soil is fairly productive. Practices that maintain tilth and fertility are needed. Prevention of overgrazing, weed control, and supplemental irrigation help to maximize forage yields. A good cropping system on this soil includes a pasture of orchardgrass and white clover for 5 or 6 years followed by oats for 1 year.

Most crops respond to nitrogen, phosphorus, and potassium. Legumes benefit from applications of agricultural lime. Capability subclass VIs.

3D-Barneston gravelly coarse sandy loam, 15 to 30 percent slopes. This moderately steep soil is somewhat excessively drained. It formed in gravelly glacial outwash under conifers along the foothills of the Cascades. Slopes are short and average about 20 percent. Elevation ranges from 500 to 1,200 feet. The annual precipitation is 45 to 70 inches, mean annual air temperature is about 49 degrees F, and the frost-free season averages about 155 days. Areas are long and narrow along drainageways and terrace breaks.

Included with this soil in mapping are as much as 10 percent soils that have a thin, black very cherty loam surface layer and subsoil underlain by shattered andesite at a depth of 1 to 3 feet.

In a typical profile a mat of extremely acid undecomposed needles and wood overlies a 5-inch, very dark brown and very dark grayish brown, very strongly acid gravelly coarse sandy loam surface layer. The subsoil, to a depth of 13 inches, is dark yellowish brown, strongly acid gravelly coarse sandy loam. The substratum, to a depth of more than 60 inches, is brown, medium acid very gravelly sand.

Permeability is rapid. The available water capacity is low. Surface runoff is medium, and there is a moderate erosion hazard. Few roots grow into the substratum.

Most of this soil is in woodland.

This soil is suited to the production of Douglas-fir. It is capable of producing annually 135 cubic feet (CMAI), or 560 board feet (Scribner rule), per acre. Tree harvest by conventional methods is feasible any time during the year. Hand planting of Douglas-fir helps to establish a more uniform stand than natural seeding, but the gravel content hampers hand planting.

Slope is the main limitation to urban development. Drainage fields for septic tanks are difficult to lay out and construct, and there is a potential of polluting ground water; therefore, other uses such as open space and wildlife habitat are more suitable for this soil. Forested areas provide a habitat for black-tailed deer. Capability subclass VIe.

3E-Barneston gravelly coarse sandy loam, 30 to 45 percent slopes. This steep soil is somewhat excessively drained. It formed in gravelly glacial outwash under coniferous trees along drainageways and on breaks between areas of less sloping Barneston soils. Slopes are 100 to 200 feet in length. Elevation ranges from 500 to 1,200 feet. The annual precipitation is 45 to 70 inches, mean annual air temperature is about 49 degrees F, and the frost-free season averages about 155 days.

Included with this soil in mapping are as much as 5 percent soils that are underlain by compacted till at moderate depths and some areas of soils that have slopes of as much as 65 percent.

In a typical profile a mat of extremely acid undecomposed needles and wood overlies a 5-inch, very dark brown and very dark grayish brown, very strongly acid gravelly coarse sandy loam surface layer. The subsoil, to a depth of 13 inches, is dark yellowish brown, strongly acid gravelly coarse sandy loam. The substratum, to a depth of more than 60 inches, is brown, medium acid very gravelly sand.

Permeability is rapid. The available water capacity is low. Surface runoff is rapid, and there is a severe erosion hazard. Few roots grow into the substratum.

Most of the acreage of this soil is woodland.

This soil is suited to the production of Douglas-fir. It is capable of producing annually 135 cubic feet (CMAI), or 560 board feet (Scribner rule), per acre. Tree harvest by conventional methods is difficult because of slope. Hand planting of Douglas-fir helps to establish a more uniform stand than natural seeding, but the gravel content hampers hand planting.

This soil is limited for homesites by the steep slope. Drainage fields for septic tanks are difficult to lay out and construct. Cut slopes slump easily. Forested areas provide habitat for black-tailed deer. Capability subclass VIIe.

4A-Bellingham silty clay loam. This nearly level soil is poorly drained. It formed in alluvium in upland depressions. Elevation ranges from 20 to 600 feet. Vegetation is primarily grasses and sedges and some conifers and hardwoods. The annual precipitation is 35 to 45 inches, and the mean annual air temperature is 50 degrees F. The frost-free season is about 166 days. This soil is generally in areas of 5 to 20 acres, but an area of 120 acres is on Anderson Island. Most areas are long and narrow, but a few are nearly round. Slopes dominantly range from 0 to 2 percent, but in a few places the slope is as much as 7 percent.

Included with this soil in mapping are areas of soils that have gravelly sand at a depth of 12 to 18 inches.

In a typical profile the surface layer is mottled, very dark grayish brown silty clay loam about 4 inches thick. In places the surface layer is black muck. The subsoil, to a depth of 11 inches, is mottled, brown clay. The substratum, to a depth of 60 inches, is mottled dark grayish brown clay.

This soil is poorly drained. Reaction ranges from strongly acid to neutral. Permeability is slow. The available water capacity is high. Surface runoff is ponded to slow, and the erosion hazard is none to slight. Very few roots penetrate the substratum.

This soil is better suited to crops, mainly hay and pasture, and wildlife habitat than to other uses because of wetness.

Careful management is required and conservation practices are more difficult to apply and maintain when this soil is cultivated. Tiling or open ditching reduces wetness. Prevention of overgrazing and weed control help to maximize forage yields.

The organic matter content can be maintained by growing green manure crops and using a suitable cropping system. Green manure crops add organic matter, improve tilth, and make the soil easier to work. A suitable cropping system includes a pasture of meadow foxtail, timothy, white clover, and big trefoil for 5 or 6 years followed by oats for 1 or 2 years.

Most crops respond to nitrogen, phosphorus, and potassium. Legumes benefit from application of agricultural lime.

When ponded, this soil serves as a resting area for ducks, herons, and other waterfowl. Plantings of smartweed, wild millet, or bulrush will improve the habitat.

The poor drainage limits this soil to water-tolerant trees, such as western redcedar and western hemlock. Red alder grows well and is suited to intensive management. The high water table remains close to the surface throughout the rainy season. Logging roads constructed on this soil require additional gravel and suitable drainage; otherwise, the movement of equipment is restricted to the very dry season. Hand planting of Douglas-fir is difficult and the survival rate is very low because of the saturated soil condition.

The primary limitations for urban development are a high water table, seasonal ponding, and the shrink-swell potential of the subsoil as it wets and dries. Septic tank drainage fields do not function properly during the wet season because of the high water table. Capability subclass IIIw.

5B-Bow silt loam, 2 to 8 percent slopes. This smooth, undulating soil is somewhat poorly drained. It formed in glacial lake sediments and till under conifers on remnant terraces adjacent to Puget Sound. Elevation ranges from 10 to 160 feet. The annual precipitation is 35 to 50 inches. The mean annual air temperature is about 50 degrees F. The frost-free season is about 180 lays.

Included with this soil in mapping are as much as 10 percent Harstine and Kitsap soils. A small percentage of Bellingham soils in depressions or drainageways is also included.

In a typical profile the surface layer is very dark brown silt loam about 2 inches thick. The subsurface layer is dark grayish brown silty clay loam about 5 inches thick. Below this is mottled, dark grayish brown and grayish brown silty clay loam and silty clay about 19 inches thick. The subsoil, to a depth of 34 inches, is mottled, grayish brown sandy clay. The substratum, to a depth of more than 60 inches, is dark grayish brown gravelly loam. Reaction is medium acid to slightly acid.

Permeability is slow in the substratum. The available water capacity is moderate. Surface runoff is slow, and the erosion hazard is slight. Few roots penetrate the subsoil.

Most of the acreage of this soil is in cutover woodland or is cultivated. Some of it is used for homesites. Hay and pasture are the chief crops. Douglas-fir is the dominant tree.

This soil is suited to the production of Douglas-fir. It is capable of producing annually 140 cubic feet (CMAI), or 610 board feet (Scribner rule), per acre. Windthrown trees are common. Root penetration is restricted by the perched water table. Tractor logging is suitable during the drier months, but compaction can be a problem. Water bars are needed in places to divert runoff from skid trails and roads. Scarification and hand planting of Douglas-fir are needed in places to overcome the effects of plant competition.

This soil is moderately productive. Needed practices are tiling, farming across the slope, using green manure and cover crops in cropping systems, and fertilizing.

A suitable cropping system on this soil includes grasses and legumes for 5 or 6 years followed by oats for 1 year as a cleanup crop. All crops respond to nitrogen. Phosphorus and lime are also beneficial. Prevention of overgrazing is needed.

A perched water table remains throughout the winter and spring rainy period. As a result, septic tank drainage fields fail to function properly and community sewerage systems must be used, especially where the amount of sewerage is substantial. Capability subclass IVw.

5C-Bow silt loam, 8 to 15 percent slopes. This sloping soil is somewhat poorly drained. It formed in glacial lake sediments and till under conifers on islands and peninsulas along Puget Sound. One of the largest areas of this soil is on Anderson Island. Elevation ranges from 10 to 160 feet. The annual precipitation is 35 to 50 inches. The mean annual air temperature is about 50 degrees F. The frost-free season is about 180 days.

Included with this soil in mapping are as much as 8 percent Harstine gravelly sandy loam, 3 percent Kitsap silt loam, and small amounts of Bellingham silty clay loam and other Bow soils.

In a typical profile the surface layer is very dark brown silt loam about 2 inches thick. The subsurface layer is dark grayish brown silty clay loam about 5 inches thick. Below this is mottled, dark grayish brown and grayish brown silty clay loam and silty clay about 19 inches thick. The subsoil, to a depth of 34 inches, is mottled, grayish brown sandy clay. The substratum, to a depth of more than 60 inches, is dark grayish brown gravelly loam. Reaction is medium acid to slightly acid.

Permeability is slow in the substratum. The available water capacity is moderate. Surface runoff is medium, and the erosion hazard is moderate. Very few roots penetrate the subsoil.

Most of the acreage of this soil is in woodland or is cultivated. Hay and pasture are the chief crops. Some areas of this soil are used for homesites.

This soil is suited to the production of Douglas-fir. It is capable of producing annually 140 cubic feet (CMAI), or 610 board feet (Scribner rule), per acre. Windthrown trees are common. Root penetration is restricted by the perched water table. Water bars are needed in places to divert runoff from roads and landings.

This soil is moderately productive. Conservation practices are necessary to control erosion and maintain fertility. Cultivation and seeding should be across the slope. A suitable cropping system on this soil includes grass and legumes for 5 or 6 years followed by oats for 1 year.

The primary limitations of this soil for urban development include slope and a perched water table. The clayey subsoil and excess water limit excavation for homesites to drier months. Tile drainage is necessary to prevent seepage into basements. Community sewerage systems must be used because septic tank drainage fields do not function properly in this wet soil. Proper site preparation includes removing trees subject to windthrow, seeding bare soil areas, and controlling runoff to check erosion. Temporary sediment basins control runoff and trap sediment during construction. Capability subclass IVe.

5D-Bow silt loam, 15 to 30 percent slopes. This moderately steep soil is somewhat poorly drained. It formed in glacial lake sediments and till under conifers on islands and peninsulas along Puget Sound. Elevation ranges from 10 to 160 feet. The annual precipitation is 35 to 50 inches. The mean annual air temperature is about 50 degrees F. The frost-free season is about 180 days.

Included with this soil in mapping are about 40 percent soils that are more sloping than this Bow soil and as much as 15 percent Harstine gravelly sandy loam, 15 to 30 percent slopes.

In a typical profile the surface layer is very dark brown silt loam about 2 inches thick. The subsurface layer is dark grayish brown silty clay loam about 5 inches thick. Below this is mottled, dark grayish brown and grayish brown silty clay loam and silty clay about 19 inches thick. The subsoil, to a depth of 34 inches, is mottled, grayish brown sandy clay. The substratum, to a depth of more than 60 inches, is dark grayish brown gravelly loam. Reaction is medium acid to slightly acid.

Permeability is slow in the substratum. The available water capacity is moderate. Surface runoff is rapid, and the erosion hazard is severe. Very few roots penetrate the subsoil.

Most of the acreage of this soil is in woodland. A small area is cultivated or used for homesites. Pasture is the chief crop.

This soil is suited to the production of Douglas-fir. It is capable of producing annually 140 cubic feet (CMAI), or 610 board feet (Scribner rule), per acre. Windthrown trees are common. Root penetration is restricted by the perched water table. Roads need to be located on favorable grades, and good drainage is needed. Cut slopes expose springs or seeps. Conservation practices are needed to maintain fertility and to reduce erosion. Cross-slope cultivation and seeding are needed to control erosion.

A suitable cropping system on this soil includes grasses and legumes for 5 or 6 years followed by oats for 1 year.

The primary limitations of this soil for urban development include slope and a perched water table. The clayey subsoil and excess water limit excavation for homesites to drier months. Septic tank effluent seeps to the surface during the rainy season. Capability subclass VIe.

6A-Briscot loam. This nearly level soil is somewhat poorly drained. It formed in alluvium under hardwoods and conifers in the Puyallup River valley. Elevation ranges from near sea level to 100 feet. Slopes are 0 to 2 percent. The surface is slightly wavy. The annual precipitation is 35 to 50 inches, and the mean annual air temperature is about 53 degrees F. The average frost-free season is about 190 days. Areas range in size from 5 to more than 300 acres; they average about 75 acres.

Included with this soil in mapping are about 10 percent a moderately well drained soil and 4 percent a well drained Puyallup soil.

In a typical profile the surface layer is dark brown loam about 11 inches thick. The underlying material, to a depth of 29 inches is mottled, dark grayish brown fine sandy loam and silt loam; between depths of 29 and more than 60 inches, it is mottled, very dark grayish brown sand and gray silty clay loam. Reaction is neutral to medium acid.

Permeability is moderately slow. In undrained areas, effective rooting depth is about 30 inches. The available water capacity is high. Surface runoff is slow, and there is a slight erosion hazard.

A wide range of cultivated crops can be grown on this soil, and it is one of the more suitable soils for row crops. Daffodil bulbs, rhubarb, lettuce, sweet corn, strawberries, blackberries, and nursery plants are common crops.

Most of this soil is protected from periodic flooding by dikes; however, as a result of changing land use in the adjacent upland areas, this soil is subject to additional flooding from urban runoff.

Under good management, this soil is highly productive. Practices that maintain tilth and fertility are necessary. Drainage can be provided by tile or open ditch methods if outlets are available. Weed control and supplemental irrigation help to maximize crop yields.

The organic matter content can be maintained by using all crop residue, plowing under green manure crops, and using a suitable cropping system. A suitable cropping system includes 2 to 4 years of strawberries, bulbs, or rhubarb and 2 to 4 years of hay and pasture. Continuous cropping that includes annual winter cover crops used as green manure is also a suitable cropping system. When tulips are grown, a minimum rotation of 5 years is necessary to control fungus.

Most crops respond to commercial fertilizer, but a soil test is needed to determine specific fertilizer needs.

This soil is subjected to residential and industrial development pressure. The soil is well suited to excavation for utility lines. It is protected from periodic flooding by dikes. Onsite sewage disposal systems function improperly or fail during the rainy season because of the high water table. The natural ability of this soil to support large loads is limited. Fill soil material is required for most types of construction. In addition, adequate drainage facilities to dispose of runoff from rooftops and pavement are necessary. Capability subclass IIw.

7A-Briscot loam, variant. This nearly level soil is moderately well drained. It formed in alluvium under hardwood and conifer trees on flood plains along South Prairie and Ohop Creeks. Elevation ranges from 300 to about 700 feet. Slopes are 0 to 3 percent. The annual precipitation is 35 to 50 inches, and the mean annual air temperature is about 50 degrees F. The average frost-free season is about 165 days.

Included with this soil in mapping are small areas of a somewhat poorly drained soil in narrow, meandering depressions.

In a typical profile the surface layer is dark brown loam about 13 inches thick. The upper part of the underlying material, to a depth of 36 inches, is dark yellowish brown sandy loam and brown sand; the lower part, between depths of 36 and 60 inches, is mottled, dark gray fine sandy loam and very gravelly sand. Reaction is medium acid.

Permeability is moderate. The effective rooting depth is more than 50 inches. The available water capacity is moderate. Surface runoff is slow, and there is a slight erosion hazard.

Most of the acreage of this soil is in pasture, and most of it is suitable for row crops such as sweet corn.

Most areas of this soil are subject to flooding. Under good management, this soil is productive. Practices that maintain tilth and fertility are necessary. Weed control and supplemental irrigation help to maximize crop yields.

The organic matter content can be maintained by using all crop residue, plowing under green manure crops, and using a suitable cropping system. For example, 5 or 6 years of orchardgrass and white clover for hay or pasture and 1 to 2 years of oats is a suitable cropping system.

Most crops respond to nitrogen, phosphorus, and potassium. Legumes benefit from applications of agricultural lime.

The primary limitations for urban development are the flooding hazard and the depth to the water table during winter and spring runoff. This soil is a good source of topsoil. Capability subclass IIIw.

8A-Buckley loam. This nearly level soil is poorly drained. It formed in the Osceola mudflow under coniferous and deciduous trees. Slopes mainly range from 0 to 2 percent, but in places the slope is as much as 4 or 5 percent. Elevation ranges from 500 to 800 feet. The mean annual precipitation is about 50 inches, mean annual air temperature is about 50 degrees F, and the frost-free season averages about 190 days.

Included with this soil in mapping are as much as 10 percent moderately well drained Alderwood soils on knolls and very poorly drained soils that formed in decaying plant remains in depressions.

In a typical profile the surface layer is very dark brown, medium acid loam about 10 inches thick. The upper part of the subsoil is brown, medium acid, prominently mottled sandy loam and gravelly :sandy loam about 28 inches thick. The lower part of the subsoil, to a depth of more than 60 inches, is grayish brown, slightly acid gravelly sandy clay loam.

Permeability is slow. The available water capacity is high. Surface runoff is very slow, and there is no erosion hazard. Very few roots penetrate the lower part of the firm subsoil.

Where drained, this soil is cultivated for hay, pasture, and corn. Undrained areas are in woodland, and alder is the dominant tree.

Under good management this soil is highly productive. Needed practices are tile drainage and maintaining tilth and fertility. Prevention of overgrazing, weed control, and supplemental irrigation help to maximize crop yields. In undrained areas this soil is suited to hay and pasture.

The organic matter content can be maintained by using all crop residue, plowing under cover crops, and using a suitable cropping system. A suitable cropping system includes a pasture of orchardgrass and white clover for 5 or 6 years followed by corn for 1 or 2 years. A pasture seeding consisting of meadow foxtail, timothy, alsike, and white clover is suitable for undrained areas.

Most crops respond to nitrogen, phosphorus, and potassium. Legumes benefit from applications of agricultural lime. Fertilizer needs are best determined by a soil test.

The poor drainage limits this soil to wader-tolerant trees, such as western redcedar and western hemlock. Red alder grows well and is suited to intensive management. The high water table remains close to the surface throughout the rainy season. Logging roads constructed on this soil require additional gravel and suitable drainage; otherwise, the movement of equipment is restricted to the very dry season. Hand planting of Douglas-fir is difficult and the survival rate is very low because of the saturated soil condition.

Residential development on this soil is centered mainly in and around the town of Buckley. The primary limitation for development is the high water table in winter and spring. Community sewerage systems must be used because septic tank drainage fields do not function properly during the rainy season. Capability subclass IIIw.

9A-Chehalis silt loam. This nearly level soil is well drained. It formed in alluvium derived from sandstone, shale, and basic igneous rocks under coniferous and deciduous trees along South Prairie and Ohop Creeks. Slopes mainly range from 0 to 3 percent, but in a few places the slope is as much as 5 percent. Elevation ranges from 200 to 550 feet. The mean annual precipitation is about 45 inches, mean annual air temperature is about 50 degrees F, and the frost-free season is about 165 days.

Included with this soil in mapping are small areas of poorly drained Reed soils and moderately well drained Briscot loam, variant.

In a typical profile the surface layer is mixed dark brown and reddish brown silt loam about 17 inches thick. The subsoil, to a depth of 55 inches, is mixed brown, dark grayish brown, and yellowish red silt loam. The substratum, to a depth of 63 inches or more, is dark grayish brown silty clay mottled with yellowish red. Reaction is neutral to slightly acid.

Permeability is moderately slow. The available water capacity is high. Surface runoff is slow, and there is a slight erosion hazard. Root penetration is deep. The soil is subject to overflow only during periods of extremely high stream runoff.

This soil is used mainly for hay and pasture. Almost all of it is cultivated. A wide range of cultivated crops can be grown.

Under good management this soil is highly productive. Practices that maintain tilth and fertility are needed. Prevention of overgrazing, weed control, and supplemental irrigation help to maximize crop yields.

The organic matter content can be maintained by using all crop residue, plowing under cover crops, and using a suitable cropping system. A suitable cropping system includes a pasture of orchardgrass and white clover for 5 or 6 years followed by corn or oats for 1 or 2 years. Strawberries or rhubarb for 2 to 4 years can be substituted for corn or oats, and the pasture of orchardgrass and white clover can be reduced to 2 to 4 years in the rotation.

Most crops respond to nitrogen, phosphorus, and potassium. Legumes benefit from applications of agricultural lime. Fertilizer needs are best determined by onsite testing.

This soil has few limitations for homesite construction except that during the rainy season flooding may occur because of very high stream runoff. Onsite sewage disposal systems may occasionally function improperly during this period. The natural ability of this soil to support large loads is limited. Capability subclass IIw.

10C-Cinebar silt loam, 6 to 15 percent slopes. This sloping soil is well drained. It formed in igneous material high in content of volcanic ash under conifers in the hills north of Elbe. Elevation ranges from 1,200 to about 2,000 feet. The annual precipitation is 50 to 90 inches., mean annual air temperature is about 47 degrees F, and the frost-free season is about 150 days.

Included with this soil in mapping are areas of soils similar to this Cinebar soil that are nearly leve1 to gently sloping. Some areas are as much as 10 percent Wilkeson gravelly silt loam, 6 to 15 percent slopes.

In a typical profile a mat of undecomposed needles and wood overlies a 3-inch surface layer of very dark grayish brown silt loam. Between depths of 3 and 60 inches, the subsoil is dark brown and dark yellowish brown silt loam. Reaction is slightly acid to medium acid.

Permeability is moderate. The available water capacity is high. Surface runoff is medium, and the erosion hazard is moderate. Root penetration is deep.

This soil is used mainly for timber production. Much of the acreage is in second growth woodland. A small area is used for homesites.

Under good management, this soil is fairly productive. Practices that reduce erosion and maintain tilth and fertility are necessary. Prevention of overgrazing, weed control, fertilizer, and supplemental irrigation help to maximize forage yields.

The organic matter content can be maintained by using all crop residue, plowing under cover crops, and using a suitable cropping system. For example, 5 or 6 years of orchardgrass and white clover for hay or pasture and 1 to 2 years of oats is a suitable cropping system.

Most crops respond to nitrogen, phosphorus, and potassium fertilizers. Legumes benefit from applications of agricultural lime.

This soil is well suited to the production of Douglas-fir. It is capable of producing annually 190 cubic feet (CMAI), or 980 board feet (Scribner rule), per acre. This soil has few restrictions for timber production except plant competition, which prevents adequate restocking, either natural or artificial, without proper site preparation.

The soil is subject to development for recreational homesites. The primary limitation for urban development is slope, but onsite sewage disposal systems can be designed to offset this limitation. Capability subclass IIIe.

10D-Cinebar silt loam, 15 to 30 percent slopes. This moderately steep soil is well drained. It formed in igneous material high in content of volcanic ash under conifers in the hills north of Elbe. Elevation ranges from 1,200 to about 2,000 feet. The annual precipitation is 50 to 90 inches, mean annual air temperature is about 47 degrees F, and the frost-free season is about 150 days.

Included with this soil in mapping are as much as 10 percent Scamman soils and exposed andesite rock.

In a typical profile a mat of undecomposed needles and wood overlies a 3-inch surface layer of very dark grayish brown silt loam. Between depths of 3 and 60 inches, the subsoil is dark brown and dark yellowish brown silt loam. Reaction is slightly acid to medium acid.

Permeability is moderate. The available water capacity is high. Surface runoff is medium to rapid, and the erosion hazard is moderate to severe. Root penetration is deep.

This soil is used mainly for timber production. Much of the acreage is in second growth woodland. A small area is used for homesites.

This soil is well suited to the production of Douglas-fir. It is capable of producing annually 190 cubic feet (CMAI), or 980 board feet (Scribner rule), per acre. This soil has few limitations for timber production except plant competition, which prevents adequate restocking, either natural or artificial, without proper site preparation. Soil losses are minimized by special erosion control practices. Roads need to be located on favorable grades. Water bars or culverts are needed in places to control runoff from roads.

The soil is subject to development for recreational homesites. The primary limitation for homesite development is slope. A site preparation system that controls runoff and maintains esthetic value is needed. Bare soil areas need to be seeded as quickly as possible. Long slopes require terraces or benches at intervals of 50 feet or less.

Under good management, this Cinebar soil is fairly productive. Practices that reduce erosion and maintain tilth and fertility are necessary. Prevention of overgrazing, weed control, and fertilizer help to maximize forage yields.

The organic matter content can be maintained by using all crop residue, plowing under cover crops, and using a suitable cropping system. For example, 5 or 6 years of orchardgrass and white clover for hay or pasture and 1 to 2 years of oats is a suitable cropping system.

Most crops respond to applications of nitrogen, phosphorus, and potassium fertilizers. Legumes benefit from applications of agricultural lime. Capability subclass IVe.

10E-Cinebar silt loam, 30 to 45 percent slopes. This steep soil is well drained. It formed in igneous material high in content of volcanic ash under conifers in the hills north of Elbe. Elevation ranges from 1,200 to about 2,000 feet. The annual precipitation is 50 to 90 inches, mean annual air temperature is about 47 degrees F, and the frost-free season is about 150 days.

Included with this soil in mapping are small areas of exposed bedrock.

In a typical profile a mat of undecomposed needles and wood overlies a 3-inch surface layer of very dark grayish brown silt loam. Between depths of 3 and 60 inches, the subsoil is dark brown and dark yellowish brown silt loam. Reaction is slightly acid to medium acid.

Permeability is moderate. The available water capacity is high. Surface runoff is rapid, and the erosion hazard is severe. Root penetration is deep.

This soil well suited to the production of Douglas-fir. It is capable of producing annually 190 cubic feet (CMAI), or 980 board feet (Scribner rule), per acre. This soil has few limitations for timber production except plant competition, which prevents adequate restocking, either natural or artificial, without proper site preparation. Conventional methods can be used for tree harvest, but they are limited by slope. Soil losses are high unless controlled by special practices. Roads need to be located or, favorable grades. Water bars or culverts are needed in places to control runoff from roads. Capability subclass VIe.

11A-Coastal beaches. Coastal beaches are long, narrow areas of sloping, gravelly beaches. In places they are sandy. These beaches are above mean tide but are swept by storm waves. They are bare of vegetation.

Included with this unit in mapping are small areas of Hydraquents. Coastal beaches are used for recreation. Capability subclass VIIIw.

12A-Dupont muck. This level, organic soil is very poorly drained. It formed in decomposing shrubs, sedges, grasses, and diatomaceous earth in narrow depressions of the glacial till plain. Slopes are 0 to 1 percent. Elevation ranges from 150 to 1,000 feet. The annual precipitation is 35 to 70 inches, mean annual air temperature is about 48 degrees F, and the average frost-free season is about 150 days.

Included with this soil in mapping is a peat soil that extends to a depth of more than 5 feet. Also included are some areas that are as much as 15 percent Tisch silt or 15 percent soils that are underlain at shallow depths by clay or gravelly sand.

In a typical profile the surface layer is black muck to a depth of 13 inches. It is underlain by 3 inches of volcanic ash and 52 inches of black muck. Reaction is strongly acid and very strongly acid.

Permeability is moderately slow. The available water capacity is high. Surface runoff is ponded, and there is no erosion hazard. Root penetration is deep.

This soil is used mainly for hay and pasture. Some areas are used for blueberries and hops.

Under good management, this soil is productive. Practices that maintain tilth and fertility are necessary. Drainage can be provided by tile or open ditch methods if outlets are available. Weed control, prevention of overgrazing, and fertilizer help to maximize forage yields.

Subsidence is excessive unless the water table is controlled and maintained near the surface. Where the areas are drained, a typical cropping system includes a pasture of orchardgrass and white clover for 5 or 6 years followed by oats for 1 or 2 years. Continuous cropping with vegetables and an annual winter cover crop that is used as a green manure is also suitable. A pasture seeding consisting of meadow foxtail, timothy, big trefoil, and white clover is suitable for undrained areas. Deep tillage may be needed occasionally to break up tillage pans.

Most crops respond to nitrogen, phosphorus, and potassium. Legumes benefit from applications of agricultural lime. Fertilizer needs are best determined by a soil test.

This soil provides excellent habitat for waterfowl, such as mallard, pintail, wood duck, and other wildlife.

This soil has poor potential for homesites. It is unable to support any load without settling. Filling with soil material or other stabilizing methods are required for construction. Onsite sewage disposal systems function improperly or fail because of the high water table. Capability subclass IIIw.

13B-Everett gravelly sandy loam, 0 to 6 percent slopes. This nearly level to undulating soil is somewhat excessively drained. It formed in gravelly glacial outwash under conifers. Elevation ranges from 200 to 700 feet. The annual precipitation is 35 to 45 inches, and the mean annual air temperature is about 50 degrees F. The frost-free season is about 180 days. Most areas of this soil are gently sloping, but some places are broken by steep slopes 15 to 70 feet long.

Included within this soil in mapping are 10 percent Neilton gravelly loamy sand and less than 10 percent Alderwood and sandy Indianola soils.

In a typical profile the surface layer is very dark brown gravelly sandy loam about 2 inches thick. The subsoil, between depths of 2 and 19 inches, is dark yellowish brown gravelly sandy loam and dark brown very gravelly coarse sandy loam. The substratum, between depths of 19 and more than 60 inches, is clean, loose very gravelly sand. Reaction is medium acid.

Permeability is rapid. The available water capacity is low. Surface runoff is slow, and there is little or no erosion hazard. The effective rooting depth is more than 4 feet.

This soil is used for home and industrial sites, as woodland, and as wildlife habitat. It is also used for Christmas tree production.

This soil is suited to the production of Douglas-fir. It is capable of producing annually 135 cubic feet (CMAI), or 560 board feet (Scribner rule) per acre. Under good management, the production of merchantable timber can be increased. Tree harvest by conventional methods is feasible anytime during the year. Hand planting of Douglas-fir helps to establish a more productive stand than often results from natural regeneration on these soils.

Large areas of this soil are under native vegetation, but they are rapidly being urbanized (fig. 11). This soil is among the least desirable in the Area for farming, but it is one of the most desirable for homesites and as a source of gravel for construction purposes. There are no limitations for urban development. However, septic waste from drain fields endanger ground water supplies because the soil is rapidly permeable. Capability subclass IVs.

13C-Everett gravelly sandy loam, 6 to 15 percent slopes. This rolling soil is somewhat excessively drained. It formed in gravelly glacial outwash under conifers. Elevation ranges from 200 to 700 feet. The annual precipitation is 35 to 45 inches, and the mean annual air temperature is about 50 degrees F. The frost-free season is about 180 days. Areas range from 5 acres to more than 400 acres in size.

Included with this soil in mapping are about 8 percent Alderwood soils. Also included are some areas that are as much as 5 percent sandy Indianola soils and 10 percent gravelly Neilton soils and less sloping Everett Soils.

In a typical profile the surface layer is very dark brown gravelly sandy loam about 2 inches thick. The subsoil, between depths of 2 and 19 inches, is dark yellowish brown gravelly sandy loam and dark brown very gravelly coarse sandy loam. The substratum, between depths of 19 and more than 60 inches, is clean, loose very gravelly sand. Reaction is medium acid.

Permeability is rapid. The available water capacity is low. Surface runoff is slow, and the erosion hazard is slight. The effective rooting depth is more than 4 feet.

This soil is used for home and industrial sites, as woodland, and as wildlife habitat. It is also used for Christmas tree production.

This soil is suited to the production of Douglas-fir. It is capable of producing annually 135 cubic feet (CMAI), or 560 board feet (Scribner rule), per acre. Under good management, the production of merchantable timber can be increased. Tree harvest by conventional methods is feasible anytime during the year. Hand planting of Douglas-fir helps to establish a more productive stand than often results from natural regeneration on these soils.

This soil is suitable for urban uses. Septic tank drainage fields function properly throughout the year. However, because the soil is very permeable, there is a potential of polluting ground water. Dwelling and road construction can be designed to reduce the number of cuts and fills. During construction, topsoil needs to be stockpiled and natural vegetation needs to be protected to maintain the esthetic value of the site. Capability subclass VIs.

13D-Everett gravelly sandy loam, 15 to 30 percent slopes. This moderately steep soil is somewhat excessively drained. It formed in gravelly glacial outwash under conifers. Elevation ranges from 200 to 700 feet. The annual precipitation is 35 to 45 inches, and the mean annual air temperature is about 50 degrees F. The frost-free season is about 180 days. Most areas are about 20 acres in size. They are long and narrow along drainageways or along terrace breaks between areas of other less sloping Everett soils.

Included with this soil in mapping are other Everett soils that have slopes of more than 30 percent. Also included are soils with a weakly cemented, compact substratum.

In a typical profile the surface layer is very dark brown gravelly sandy loam about 2 inches thick. The subsoil, between depths of 2 and 19 inches, is dark yellowish-brown gravelly sandy loam and dark brown very gravelly coarse sandy loam. The substratum, between depths of 19 and more than 60 inches, is clean, loose very gravelly sand. Reaction is medium acid.

Permeability is rapid. The available water capacity is low. Surface runoff is medium, and the erosion hazard is moderate. The effective rooting depth is more than 4 feet.

This soil is used for woodland and as wildlife habitat. It also is used for Christmas tree production.

This soil is suited to the production of Douglas-fir. It is capable of producing annually 135 cubic feet (CMAI), or 560 board feet (Scribner rule), per acre. Under good management, the production of merchantable timber can be increased. Tree harvest by conventional methods is feasible anytime during the year. Hand planting of Douglas-fir helps to establish a more productive stand than often results from natural regeneration on these soils.

Slope is the dominant limitation of this soil. Drainage fields for septic tanks are difficult to lay out and construct. This soil is very permeable, and there is a potential of polluting ground water. Such uses as open space and wildlife habitat are suited to this soil. The intensive urban uses are better suited to other nearby, less sloping Everett soils than to this soil. Capability subclass VIe.

14B-Everett stony sandy loam, 0 to 6 percent slopes. This nearly level to undulating soil is somewhat excessively drained. It is in old glacial upland drainages. It formed in gravelly glacial outwash under conifers. Elevation ranges from 450 to 700 feet. The annual precipitation is 35 to 45 inches, and the mean annual air temperature is about 50 degrees F. The frost-free season is about 180 days.

In a typical profile the surface layer is very dark brown stony and gravelly sandy loam about 2 inches thick. The subsoil, between depths of 2 and 20 inches, is dark yellowish brown and dark brown stony and very gravelly sandy loam. The substratum, between depths of 20 and 60 inches, is clean, loose very stony and very gravelly sand. Reaction is medium acid.

Permeability is rapid. The available water capacity is low. Surface runoff is slow, and there is little or no erosion hazard. The effective rooting depth is more than 4 feet.

This soil is used for urban development, as woodland, and as wildlife habitat. It is also used for Christmas tree production.

This soil is suited to the production of Douglas-fir. It is capable of producing annually 135 cubic feet (CMAI), or 560 board feet (Scribner rule), per acre. Under good management, the production of merchantable timber can be increased. Tree harvest by conventional methods is feasible anytime during the year. Hand planting of Douglas-fir helps to establish a more uniform stand than natural seeding, but stones hamper planting. Dog-hair thickets of Douglas-fir result from natural regeneration in places.

The primary limitation for urban development is the presence of stones. This can be overcome through the use of heavy equipment when preparing building sites. The large amounts of coarse fragments and the closeness of the substratum may cause some excavation problems, especially during the installation of underground utility lines. Where residential density is high, there is a potential of effluent from septic tank drainage fields polluting ground water because the soil is rapidly permeable. Natural vegetation needs to be protected to maintain the esthetic value of the site. Capability subclass VIs.

15A-Greenwater loamy sand. This nearly level soil is somewhat excessively drained. It formed under conifers in sandy alluvium derived mainly from andesite and pumice under conifers. The largest areas are on terraces along the Nisqually River. Slopes are mainly 0 to 3 percent, but in some areas they are as much as 4 or 5 percent. Elevation ranges from 500 to 1,000 feet. The annual precipitation is 50 to 70 inches, mean annual air temperature is about 49 degrees F, and the frost-free season is about 190 days.

Included with this soil in mapping are smell areas of Aquic Xerofluvents, level, and Pilchuck soils.

In a typical profile the surface layer is very dark brown loamy sand about 9 inches thick. The subsoil, between depths of 9 and 19 inches, is dark yellowish brown loamy sand. The substratum, between depths of 19 and more than 61 inches, is very dark grayish brown and very dark gray sand stratified with thin layers of sandy loam and silt loam. It contains a few large stones. Reaction is medium acid.

Permeability is moderate. The available water capacity is low to moderate. Surface runoff is slow, and there is no erosion hazard. Root penetration is deep.

Most of this soil is in woodland. The remainder is used for homesites or pasture. The forested areas provide good habitat for black-tailed deer.

Under good management this Greenwater soil is fairly productive. Practices that maintain tilth and fertility are necessary. Prevention of overgrazing, weed control, fertilizer, and supplemental irrigation help to maximize forage yields.

The organic matter content can be maintained by using all crop residue, plowing under cover crops, and using a suitable cropping system. For example, 5 or 6 years of orchardgrass and white clover for hay or pasture and 1 to 2 years of oats is a suitable cropping system.

Most crops respond to nitrogen, phosphorus, and potassium fertilizers. Legumes benefit from applications of agricultural lime.

This soil is suited to the production of Douglas-fir. It is capable of producing annually 145 cubic feet (CMAI), or 630 board feet (Scribner rule), per acre. Tree harvest by conventional methods is feasible anytime during the year. Hand-planting of Douglas-fir helps to establish a more uniform stand than natural seeding.

This soil is not near highly populated areas, and urban development pressure is minimal. However, along the Nisqually River this soil is used for recreational homesites. Septic tank drainage fields function properly throughout the year. Because the soil is very permeable, there is a hazard of polluting ground-water supplies or nearby streams. This soil is well suited to excavation. It is a good source of roadfill. Capability subclass IVs.

16B-Harstine gravelly sandy loam, 0 to 6 percent slopes. This nearly level to undulating soil is moderately well drained. It formed in sandy glacial till on the broad uplands in the western part of the survey area. The vegetation is conifers. Elevation ranges from sea level to 400 feet. The annual precipitation is 40 to 50 inches, mean annual air temperature is about 50 degrees F, and the frost-free season is about 180 days. Areas average about 50 acres in size.

Included with this soil in mapping are about 5 percent somewhat excessively drained Indianola soils, 6 percent poorly drained and very poorly drained Bellingham, Dupont, and Norma soils; and wet spots less than 4 acres in size. Also included in some areas are as much as 5 percent Harstine soils that have slopes of more than 6 percent.

In a typical soil profile a thin mat of undecomposed very strongly acid needles and wood overlies a surface layer of dark yellowish brown gravelly sandy loam 5 inches thick. Between depths of 5 and 31 inches, the subsoil is dark brown, brown, and dark yellowish brown gravelly sandy loam. Between depths of 31 and more than 60 inches, the substratum is compact glacial till that is weakly cemented in places. Reaction is medium acid to very strongly acid.

A perched water table develops for short periods during the winter and spring rainy seasons. Permeability is moderate in the upper part of the profile but is very slow in the weakly cemented and compact substratum. A few roots penetrate this layer in cracks. The available water capacity is low. Surface runoff is slow, and the erosion hazard is slight.

Although much of the acreage of this soil is in woodland or is cultivated, urban development is eliminating logging and brush picking activities in the urban-rural fringe areas. Hay and pasture are the chief crops. Strawberries and cane fruit, principally raspberries, are the minor crops. The weakly cemented substratum limits suitability of deep rooted crops.

Under good management, this soil is fairly productive. Practices that maintain soil tilth and fertility are needed. Prevention of overgrazing, weed control, and supplemental irrigation help to maximize forage yields.

The organic matter content can be maintained by using all crop residue, plowing under cover crops, and using a suitable cropping system. A typical cropping system includes a pasture of orchardgrass and white clover for 5 or 6 years followed by oats for 1 year or strawberries for 3 years.

Most crops respond to nitrogen, phosphorus, and potassium. Legumes benefit from applications of agricultural lime. Fertilizer needs are best determined by a soil test.

This soil is suited to the production of Douglas-fir. It is capable of producing annually 115 cubic feet (CMAI), or 460 board feet (Scribner rule), per acre. This soil has few limitations for timber production except plant competition, which prevents adequate restocking, either natural or artificial, without proper site preparation. During periods of heavy rainfall, the perched water table is at a moderate depth in places. However, it is generally of short duration and consequently has little or no effect on root growth.

The increase in population and the movement; of people from urban to rural areas have resulted in greater residential use of this soil. Homesite excavation is limited by the cemented substratum, and in areas of moderate to high population, onsite sewage disposal systems fail or do not function properly during periods of high rainfall because of this very slowly permeable layer. This soil has a natural ability to support large loads. Capability subclass IVs.

16C-Harstine gravelly sandy loam, 6 to 15 percent slopes. This rolling soil is moderately well drained. It formed in sandy glacial till and is most extensive on the broad uplands in the western part of the survey area. The vegetation is conifers. Elevation ranges from sea level to 400 feet. The annual precipitation is 40 to 50 inches, mean annual air temperature is 50 degrees F, and the frost-free season is about 180 days. Areas average about 300 acres in size. Most slopes are about 8 percent.

Included with this soil in mapping are small areas of Indianola loamy sand and Neilton gravelly loamy sand on side slopes and small areas of Norma fine sandy loam and Dupont muck in troughs. Also included are some areas of Harstine soils that are nearly level to undulating or moderately steep and ponded areas that are less than 4 acres in size.

In a typical profile a thin mat of undecomposed very strongly acid needles and wood overlies a surface layer of dark yellowish brown gravelly sandy loam 5 inches thick. The subsoil, to a depth of 31 inches, is dark yellowish brown, brown, and dark brown gravelly sandy loam. The substratum, to a depth of more than 60 inches, is compact glacial till that is cemented in places. Reaction is medium acid to very strongly acid.

A water table is perched above the very slowly permeable, weakly cemented, and compact substratum during periods of heavy rainfall. However, ponding is of short duration because the water flows laterally above the substratum and seeps at the bottom of slopes. A few roots penetrate the dense substratum in cracks. The available water capacity is low. Surface runoff is medium, and the erosion hazard is moderate.

Much of the acreage is in second or third growth woodland. Salal, evergreen huckleberry, and swordfern are minor forest crops. Urban development, particularly residential subdivision, is rapidly replacing the woodland in the urban-rural fringe areas. Hay and pasture are the chief crops; strawberries and cane fruit, principally raspberries, are the minor crops. The dense substratum limits the suitability of deep-rooted crops.

Under good management, this soil is fairly productive. Practices that reduce erosion and maintain tilth and fertility are necessary. Prevention of overgrazing, weed control, fertilizer, and supplemental irrigation help to maximize forage yields.

The organic matter content can be maintained by using all crop residue, plowing under cover crops, and using a suitable cropping system. For example, 5 or 6 years of orchardgrass and white clover for hay or pasture and 1 year of oats or 3 years of strawberries is a suitable cropping system.

Most crops respond to applications of nitrogen, phosphorus, and potassium fertilizers. Legumes benefit from applications of agricultural lime.

This soil is suited to the production of Douglas-fir. It is capable of producing annually 115 cubic feet (CMAI), or 460 board feet (Scribner rule), per acre. This soil has few limitations for timber production except plant competition, which prevents adequate restocking, either natural or artificial, without proper site preparation. Except for occasional matting of roots because of the weakly cemented layer, root growth is normal.

This soil is subject to urbanization pressure. It has an inherent ability to support a large load. Slope and the weakly cemented substratum are limitations. In areas of moderate to high population density onsite sewage disposal systems fail or do not function properly during the winter heavy rainfall periods. Excavation for basements and utility lines is difficult. The weakly cemented layer is rippable. Topsoil needs to be stockpiled and subsequently used to cover excavated soil material. Capability subclass IVe.

16D-Harstine gravelly sandy loam, 15 to 30 percent slopes. This moderately steep soil is moderately well drained. It formed in sandy glacial till on the broad uplands in the western part of the survey area. The vegetation is conifers. Elevation ranges from sea level to 400 feet. The annual precipitation is 40 to 50 inches, mean annual air temperature is about 50 degrees F, and the frost-free season is about 180 days. Areas are long and narrow and are along drainageways and on breaks between areas of other less sloping Harstine soils. Slopes are about 150 to 300 feet in length.

Included with this soil in mapping on the lower portions of slopes are small areas of Neilton gravelly loamy sand, Indianola loamy sand, and Ragnar sandy loam. Some areas of less sloping Harstine soils are also included.

In a typical profile a thin mat of undecomposed very strongly acid needles and wood overlies a surface layer of dark yellowish brown gravelly sandy loam 5 inches thick. The subsoil, to a depth of 31 inches, is dark yellowish brown, brown, and dark brown gravelly sandy loam. The substratum, to a depth of more than 60 inches, is compact glacial till that is cemented in places. Reaction is medium acid to very strongly acid.

A water table is perched above the very slowly permeable, weakly cemented, and compact substratum for short periods of time. It flows on top of this dense layer to seeps on the lower portions of the moderately steep slopes. A few roots enter the substratum through cracks. The available water capacity is low. Surface runoff is medium or rapid, and the erosion hazard is moderate or severe. Slumping of soil material occurs occasionally, particularly on the more sloping areas of this soil.

Most of the acreage of this soil is in woodland. Salal, evergreen huckleberry, and swordfern are minor forest crops. The remainder is used as wild pasture and for urbanization.

This soil is suited to the production of Douglas-fir. A fully stocked, even-aged stand is capable of producing annually 115 cubic feet (CMAI), or 460 board feet (Scribner rule), per acre. Plant competition prevents adequate restocking, either natural or artificial, without proper site preparation. Conventional methods can be use l for tree harvest, but they may be limited during the rainy period. Soil losses are minimized by use of special erosion control practices.

Excavation involves ripping the weakly cemented substratum. The topsoil needs to be stockpiled and subsequently used to cover excavated soil material. A site preparation system that controls runoff and maintains the esthetic value is needed. During the winter and spring rainy season, septic effluent from onsite sewage disposal units may seep at points farther down the slope. Capability subclass VIe.

16E-Harstine gravelly sandy loam, 30 to 45 percent slopes. This steep soil is moderately well drained. It formed in sandy glacial till on broad uplands in the western part of the survey area. The vegetation is conifers. Elevation ranges from sea level to 400 feet. The annual precipitation is 40 to 50 inches, mean annual air temperature is about 50 degrees F, and the frost-free season is about 180 days. Areas are long and narrow along drainageways that empty into Puget Sound.

Included with this soil in mapping on the lower portions of slopes are small areas of Neilton gravelly loamy sand, Indianola loamy sand, and Kitsap silt loam. Also included are some areas, mainly along Puget Sound, of very steep Xerochrepts.

In a typical profile a thin mat of undecomposed very strongly acid needles and wood overlies a surface layer of dark yellowish brown gravelly sandy loam 5 inches thick. The subsoil, to a depth of 31 inches, is dark yellowish brown, brown, and dark brown gravelly sandy loam. The substratum, to a depth of more than 60 inches, is compact glacial till that is cemented in places. Reaction is medium acid to very strongly acid.

Permeability is very slow in the weakly cemented and compacted substratum. The available water capacity is low. Surface runoff is rapid, and the erosion hazard is severe. Slumping of soil material is common.

All the acreage of this soil is in woodland. This soil is suited to the production of Douglas-fir. A fully stocked, even-aged stand is capable of producing annually 115 cubic feet (CMAI), or 460 board feet (Scribner rule), per acre. Plant competition prevents adequate restocking, either natural or artificial, without proper site preparation. Conventional methods can be used for tree harvest, but they are limited by slope. Soil losses are high unless controlled by special erosion practices.

This soil is poorly suited to use as homesites because of the steep slope. Drainage fields for septic tanks are difficult to layout and construct. Cut slopes expose springs or seeps. This soil is well suited to use as open space, woodland, and wildlife habitat. Capability subclass VIIe.

17A-Hydraquents, level. This unit is made up of low-lying, brackish areas within the overflow limits of high tides. In most places the soil is a deep deposit of delta alluvium consisting mainly of silt, clay, and muck.

This unit is very poorly drained. Surface runoff is very slow. Capability subclass VIIIw.

18B-Indianola loamy sand, 0 to 6 percent slopes. This nearly level to undulating soil is somewhat excessively drained. It formed in sandy glacial outwash on broad uplands. The vegetation is conifers. Elevation ranges from 200 to 800 feet. The annual precipitation averages about 35 inches. Annual air temperature averages about 50 degrees F, and the frost-free season averages about 180 days. This soil is adjacent to areas of a soil that has a hardpan at a depth of about 3 feet and to areas of a soil that is deep, loose, and gravelly. One of the largest areas of this soil, covering over 600 acres, is south of Puyallup.

Included with this soil in mapping are about 8 percent Alderwood, Everett, and Neilton soils. Some long, narrow areas of poorly drained Norma fine sandy loam are also included.

In a typical profile the surface layer, 7 inches thick, is dark brown loamy sand. The underlying material, to a depth of more than 60 inches, is dark yellowish brown, brown, or olive brown sand. Reaction is slightly or medium acid (fig. 12).

Permeability is rapid. The available water capacity is low to moderate. Surface runoff is slow, and the erosion hazard is slight. Roots extend to a depth of more than 60 inches.

Because this soil is suitable for onsite sewage disposal systems, much of it is being converted to urban uses in the urban-rural fringe areas. The remainder is cultivated or in woodland. Hay and pasture are the chief crops. Strawberries and cane fruit, principally raspberries, are the minor crops.

Under good management, this soil is moderately productive. Practices that maintain tilth and fertility are necessary. Prevention of overgrazing, weed control, and supplemental irrigation help to maximize forage yields.

By using all crop residue, plowing under cover crops, and using a suitable cropping system the organic matter content can be maintained. An example of a suitable cropping system is a pasture of orchardgrass and white clover for 5 or 6 years followed by oats for 1 year or strawberries for 3 years.

Most crops respond to nitrogen, phosphorus, and potassium. Legumes benefit from applications of agricultural lime.

This soil is suited to the production of Douglas-fir. It is capable of producing annually 135 cubic feet (CMAI), or 570 board feet (Scribner rule), per acre. This soil has few limitations for timber production except droughtiness, which increases seedling mortality.

This soil can support high density housing units and onsite sewage disposal systems. The soil is easily excavated. However, trenches for utility lines need to be shored up as a safety precaution. Capability subclass IVs.

18C-Indianola loamy sand, 6 to 15 percent slopes. This rolling soil is somewhat excessively drained. It formed in sandy glacial outwash on broad uplands. The vegetation is conifers. Elevation ranges from 200 and 800 feet. The annual precipitation averages about 35 inches. Annual air temperature averages about 50 degrees F, and the frost-free season averages about 180 days. This soil is adjacent to areas of a soil that has a hardpan at a depth of about 3 feet and to areas of a soil that is deep, loose, and gravelly. Some areas of this soil, particularly along Puget Sound, rest upon unstable lake sediments. Areas average about 35 acres in size.

Included with this soil in mapping are about 10 percent Alderwood, Everett, and Kitsap soils. A small percentage of Ragnar fine sandy loam is included.

In a typical profile the surface layer, 7 inches thick, is dark brown loamy sand. The underlying material, to a depth of more than 60 inches, is dark yellowish brown, brown, or olive brown sand. Reaction is slightly acid and medium acid.

Permeability is rapid. The available water capacity is low to moderate. Surface runoff is medium, and the erosion hazard is moderate. Roots extend to a depth of more than 60 inches.

Because this soil is suitable for onsite sewage disposal systems, much of it is being converted to urban uses in the rural areas. The remainder is cultivated or in woodland. Hay and pasture are the chief crops. Strawberries and cane fruit, principally raspberries, are the minor crops.

This soil is moderately productive. Practices that maintain tilth and fertility and reduce erosion are necessary. Grasses seeded in bare areas protect the soil during the rainy season. Prevention of overgrazing, weed control, and supplemental irrigation help to maximize forage yields.

The organic matter content can be maintained by using all crop residue, adding barnyard manure, plowing under cover crops, and using a suitable cropping system. An example of a suitable system consists of orchardgrass and white clover for 5 or 6 years followed by oats for 1 year or strawberries for 3 years.

Most crops respond to nitrogen, phosphorus, and potassium. Legumes benefit from applications of agricultural lime.

This soil is suited to the production of Douglas-fir. It is capable of producing annually 135 cubic feet (CMAI), or 570 board feet (Scribner rule), per acre. This soil has few limitations for timber production except droughtiness, which increases seedling mortality.

This soil can support high density housing units and onsite sewage disposal systems. The soil is easily excavated. However, trenches for utility lines need to be shored up as a safety precaution. Bare soil areas erode unless seeded to a cover crop. Capability subclass IVe.

18E-Indianola loamy sand, 15 to 45 percent slopes. This moderately steep to steep soil is somewhat excessively drained. It formed in sandy glacial outwash on broad uplands and in drainageways. The average slope of this soil is about 20 percent. Elevation ranges from 200 to 800 feet. The vegetation is conifers. The annual precipitation averages about 35 inches, annual air temperature averages about 50 degrees F, and the frost-free season averages about 180 days. In drainageways this soil is adjacent to or above unstable Kitsap soil.

Included with this soil in mapping are as much as 10 percent Alderwood and Kitsap soils and small acreages of Neilton soils and other less sloping Indianola soils.

In a typical profile the surface layer is dark brown loamy sand about 5 inches thick. The underlying material, to a depth of more than 60 inches, is dark yellowish brown, brown, or olive brown sand. Reaction is slightly acid and medium acid.

Permeability is rapid. The available water capacity is low to moderate. Surface runoff is medium to rapid, and the erosion hazard is moderate to severe. Roots extend to a depth of more than 60 inches.

Most areas of this soil are covered by trees or are in wild pasture. Some less sloping areas have been urbanized.

This soil is suited to the production of Douglas-fir. It is capable of producing annually 135 cubic feet (CMAI), or 570 board feet (Scribner rule), per acre. Bare soil areas erode easily. Soil losses are minimized by diverting runoff from skid trails and roads. Hand planting of Douglas-fir in this sandy soil is preferable to aerial seeding.

The limitation for homesites is the moderately steep to steep slopes. Deep cuts made during road construction, particularly on the steep slopes, may expose unstable soil material. A site preparation system that controls runoff and maintains the esthetic value is needed. Capability subclass VIe.

19B-Kapowsin gravelly loam, 0 to 6 percent slopes. This nearly level to undulating soil is moderately well drained. It formed in glacial till under conifers, and it dominates the uplands south of Graham and in the Midland-Parkland area. Elevation ranges from 300 to 900 feet. The annual precipitation is 35 to 45 inches, mean annual air temperature is about 50 degrees F, and the frost-free season is about 180 days. Areas range from 50 acres to more than 1,000 acres.

Included with this soil in mapping are as much as 10 percent Alderwood gravelly sandy loam and about 8 percent very poorly drained Dupont and Tisch soils in basins or depressions. As much as 10 percent poorly drained Bellingham and McKenna soils in long, narrow depressions and 5 percent excessively drained Neilton soils are also included.

In a typical profile the surface layer is dark brown gravelly loam to a depth of 7 inches. The subsoil, between depths of 7 and 25 inches, is dark brown or dark yellowish brown gravelly loam and brown loam. The substratum, to a depth of more than 60 inches, is mottled olive brown loam and grayish brown gravelly loam. The substratum is compact glacial till that is cemented in places, particularly in the upper part. Reaction is strongly acid to medium acid.

A water table is perched above the very slowly permeable, weakly cemented and compact substratum during the rainy season. Very few roots penetrate below a depth of 40 inches. The available water capacity is low to moderate. Surface runoff is slow, and the erosion hazard is slight.

Much of the area of this soil is covered by second or third growth woodland. Hay and pasture are the chief crops (fig. 13). Corn for silage and strawberries are the minor crops. Urban development, particularly residential subdivision, is increasing in the Midland-Parkland area.

This soil is suited to the production of Douglas-fir. It is capable of producing annually 155 cubic feet (CMAI), or 700 board feet (Scribner rule), per acre. The primary limitation for timber production is the very slowly permeable substratum. During the rainy season, the perched water table remains at a shallow depth. When the soil is excessively wet and winds are strong, windthrow can be expected. Conventional methods can be used for tree harvest, but they are restricted to the drier months. Plant competition prevents adequate restocking, either natural or artificial, without proper site preparation. Red alder quickly invades clearcuts. Hand planting of Douglas-fir helps to establish a more uniform stand than natural seeding. Logging roads generally require surfacing.

Under good management, this Kapowsin soil is productive. Practices that maintain tilth and fertility are necessary. Prevention of overgrazing, weed control, fertilizer, and supplemental irrigation help to maximize forage yields.

The organic matter content can be maintained by using all crop residue, plowing under cover crops, and using a suitable cropping system. For example, 5 or 6 years of orchardgrass and white clover for hay or pasture and 1 year of oats or corn for silage or 3 years of strawberries is a suitable cropping system. Most crops respond to applications of nitrogen, phosphorus and potassium fertilizers. Legumes benefit from applications of agricultural lime.

Because of its proximity to the city of Tacoma, some large areas of this soil are subject to urbanization. Community sewerage systems must be used because septic tank drainage fields fail or do not function properly during the rainy season. In addition, storm sewers must be used because concentrated runoff from rooftops and roads is greater than the soil's capacity to take in water. This soil has an inherent ability to support large loads. Excavation for basements, utility lines, and drainage is difficult. The compact layer is rippable. Topsoil needs to be stockpiled and subsequently used to cover excavated soil material. Proper site preparation includes removal of undesirable trees, where possible, and planning for the safe disposal of runoff. Capability subclass IIIw.

19C-Kapowsin gravelly loam, 6 to 15 percent slopes. This rolling soil is moderately well drained. It formed in glacial till under conifers in the uplands south of Graham. Elevation ranges from 300 to 900 feet. The annual precipitation is 35 to 45 inches, mean annual air temperature is about 50 degrees F, and the frost-free season is about 180 days.

Included with this soil in mapping are about 10 percent poorly drained McKenna soils in long, narrow depressions and as much as 10 percent Kapowsin gravelly loam, 0 to 6 percent slopes.

In a typical profile the surface layer is dark brown gravelly loam to a depth of 7 inches. The subsoil, at a depth of 7 to 25 inches, is dark brown or dark yellowish brown gravelly loam and brown loam. The substratum, at a depth of 25 to more than 60 inches, is mottled, olive brown loam and grayish brown gravelly loam. It is compact glacial till that is cemented in places, particularly in the upper part. Reaction is strongly acid to medium acid.

A water table is perched above the very slowly permeable, weakly cemented, and compact substratum during the rainy season. Very few roots penetrate below a depth of 40 inches. The available water capacity is low to moderate. Surface runoff is medium, and the erosion hazard is moderate.

Much of the area of this soil is covered by second or third growth woodland. Hay and pasture are the chief crops. This soil is used for urban development.

This soil is suited to the production of Douglas-fir. It is capable of producing annually 155 cubic feet (CMAI), or 700 board feet (Scribner rule), per acre. The primary limitation for timber production is the very slowly permeable substratum. During the rainy season, the perched water table remains at a shallow depth. When the soil is excessively wet and winds are strong, windthrow can be expected. Conventional methods can be used for tree harvest, but they are restricted to the drier months. Plant competition prevents adequate restocking, either natural or artificial, without proper site preparation. Red alder quickly invades clear-cut areas. Hand planting of Douglas-fir helps to establish a more uniform stand than natural seeding. Logging roads generally require surfacing.

Under good management, this soil is productive. Practices that reduce erosion and maintain tilth and fertility are necessary. Prevention of overgrazing, weed control, fertilizer, and supplemental irrigation help to maximize forage yields.

The organic matter content can be maintained by using all crop residue, plowing under cover crops, and using a suitable cropping system. Cultivation and seeding should be across the slope. An example of a suitable cropping system on this soil is 5 or 6 years of orchardgrass and white clover for hay or pasture and 1 year of oats or corn for silage or 3 years of strawberries. Most crops respond to nitrogen, phosphorus, and potassium fertilizers. Legumes benefit from applications of agricultural lime.

Some areas of this soil are subject to urbanization. Community sewerage systems must be used because septic tank drainage fields fail or do not function properly during the rainy season. In addition, storm sewers must be used because concentrated runoff from rooftops and roads is greater than the soil's capacity to take in water. This soil has an inherent ability to support large loads. Excavation for basements, utility lines, and drainageways is difficult. The compact layer is rippable. Topsoil needs to be stockpiled and subsequently used to cover excavated soil material. Proper site preparation includes removing undesirable trees, where possible, and planning for the safe disposal of runoff. Capability subclass IVe.

19D-Kapowsin gravelly loam, 15 to 30 percent slopes. This moderately steep soil is moderately well drained. It formed in glacial till under conifers. Elevation ranges from 300 to 900 feet. The annual precipitation is 35 to 45 inches, mean annual air temperature is about 50 degrees F, and the frost-free season is about 180 days. Areas are long and narrow along drainageways or are on breaks within areas of other less sloping Kapowsin soils.

Included with this soil in mapping are small areas of soils where stones are scattered on the surface,

In a typical profile the surface layer is dark brown gravelly loam to a depth of 7 inches. The subsoil, between depths of 7 and 25 inches, is dark brown or dark yellowish brown gravelly loam and brown loam. The substratum, between depths of 25 and more than 60 inches, is mottled, olive brown loam and grayish brown gravelly loam. It is compact glacial till that is cemented in places, particularly in the upper part. Reaction is strongly acid to medium acid.

A water table is perched above the very slowly permeable, weakly cemented and compact substratum during the rainy season. Very few roots penetrate below a depth of 40 inches. The available water capacity is low to moderate. Surface runoff is medium or rapid, and the erosion hazard is moderate or severe.

Most areas of this soil are in cutover woodland. This soil is well suited to the production of Douglas-fir. It is capable of producing annually 155 cubic feet (CMAI), or 700 board feet (Scribner rule), per acre. Plant competition prevents adequate restocking, either naturally or artificially, without proper site preparation. Soil losses are minimized by using special erosion control practices and by exercising care in the selection of landings and skid trails. Springs and seeps are common on cut slopes. Tractor logging is a common method of harvesting, but it is restricted to the drier months. Some windthrown trees can be expected during the winter months when the soil is saturated.

A small acreage of this soil is cultivated. Hay and pasture are the chief crops. Practices that protect the soil and maintain tilth are necessary. Cross-slope plowing and planting help to check erosion. Prevention of grazing and weed control help to maximize forage yields.

A suitable cropping system on this soil includes 5 or 6 years of orchardgrass and white clover for hay and pasture followed by 1 year of oats. Most crops respond to commercial fertilizers. Legumes benefit from applications of agricultural lime.

Excavation of this soil involves ripping the compact substratum. The topsoil needs to be stockpiled and subsequently used to cover excavated soil material. A site preparation system that controls runoff and maintains the esthetic value is needed. During the winter and spring rainy season, septic water from onsite sewage disposal units may seep downslope. Capability subclass VIe.

19E-Kapowsin gravelly loam, 30 to 50 percent slopes. This steep soil is moderately well drained. It formed in glacial till under conifers on breaks in the broad uplands south of Graham. Elevation ranges from 300 to 900 feet. The annual precipitation is 35 to 45 inches, mean annual air temperature is about 50 degrees F, and the frost-free season is about 180 days.

Included with this soil in mapping are about 10 percent areas of very steep Kapowsin soil.

In a typical profile the surface layer is dark brown gravelly loam to a depth of 7 inches. The subsoil, between depths of 7 and 25 inches, is dark brown or dark yellowish brown gravelly loam and brown loam. The substratum, to a depth of more than 60 inches, is a mottled, olive brown loam and grayish brown gravelly loam. It is compact glacial till that is cemented in places, particularly in the upper part. Reaction is strongly acid to medium acid.

Water ponds above the very slowly permeable, weakly cemented, compact substratum during the rainy season. Very few roots penetrate below a depth of 40 inches. The available water capacity is low to moderate. Surface runoff is rapid, and the erosion hazard is severe.

All the acreage of this soil is in woodland.

This soil is suited to the production of Douglas-fir. A fully stocked, even-aged stand is capable of producing annually 155 cubic feet (CMAI), or 700 board feet (Scribner rule), per acre. Plant competition prevents adequate restocking, either natural or artificial, without proper site preparation. Conventional methods can be used for tree harvest, but they are limited by the slope. Soil losses are high unless controlled by special practices.

This soil is poorly suited to use as homesites because of the steep slope. Drainage fields for septic tanks are difficult to lay out and construct. Cut slopes expose springs or seeps. This soil is well suited to use as open space and wildlife habitat. Capability subclass VIIe.

19F-Kapowsin gravelly loam, 50 to 70 percent slopes. This very steep soil is moderately well drained. It formed in glacial till under conifers on the valley walls along the Moshel River and Ohop Creek. Elevation ranges from 300 to 900 feet. The annual precipitation is 35 to 45 inches, mean annual air temperature is about 50 degrees F, and the frost-free season is about 180 days. Areas are long and narrow on the contour. Most slopes are about 65 percent.

Included with this soil in mapping are escarpments where the several layers of the Moshel Formation are exposed.

In a typical profile the surface layer is dark brown gravelly loam to a depth of 7 inches. The subsoil, between depths of 7 and 25 inches, is a dark brown or dark yellowish brown gravelly loam and brown loam. The substratum, to a depth of more than 60 inches, is a mottled, olive brown loam and grayish brown gravelly loam. It is compact glacial till that is cemented in places, particularly in the upper part. Reaction is strongly acid to medium acid.

Water seeps along the top of the very slowly permeable, weakly cemented, compact substratum during the rainy season. Very few roots penetrate below a depth of 40 inches. The available water capacity is low to moderate. Surface runoff is rapid, and the erosion hazard is severe.

This soil is used for watersheds, wildlife habitat, and woodland. The very steep slopes and slumping preclude use of this soil for homesites.

A fully stocked, even-aged stand of Douglas-fir on this soil is capable of producing annually 155 cubic feet (CMAI), or 700 board feet (Scribner rule), per acre. A fully stocked stand of trees is difficult to maintain because of slope and the slump hazard. Red alder and bigleaf maple are quickly established in open areas. Tree covered slump areas are prominent. The very steep slopes of this soil hinder the use of conventional tree harvest methods. Erosion control measures are essential because of the severe erosion hazard.

The potential for watersheds, woodland, and wildlife habitat is maintained or increased by limited tree cutting. Diseased trees need to be cut and removed. Runoff is controlled and soil losses minimized by the retention of permanent cover. Capability subclass VIIe.

20B-Kitsap silt loam, 2 to 8 percent slopes. This undulating soil is moderately well drained. It formed in glacial lake sediments on remnant terraces along Puget Sound and on the hillside south of Puyallup. Elevation ranges from 100 to 400 feet. The vegetation is made up of conifers. The annual precipitation is 35 to 50 inches, annual air temperature averages about 50 degrees F, and the frost-free season averages about 180 days. The areas of this soil are bounded by other more sloping Kitsap soils and by soils that have a loose sandy or weakly cemented gravelly substratum. Areas of this soil average about 30 acres in size.

Included with this soil in mapping are as much as 12 percent Alderwood, Harstine, and Indianola soils and as much as 3 percent poorly drained Bellingham soils in depressions.

In a typical profile the surface layer is very dark grayish brown and dark brown silt loam about 10 inches thick. The upper part of the subsoil is brown silty clay loam about 7 inches thick. The lower part is mottled, grayish brown silty clay loam about 15 inches thick. The substratum, to a depth of more than 60 inches, is stratified, mottled, light olive brown silt loam and silty clay loam. Reaction is medium acid to neutral.

Permeability is very slow. The available water capacity is high. Few roots penetrate below a depth of 32 inches. Surface runoff is slow to medium, and the erosion hazard is slight to moderate.

Most of the acreage of this soil is cultivated or in urban uses, but some areas are in woodland. Hay and pasture are the chief crops. Strawberries and cane fruit, principally raspberries, are well suited to this soil.

Under good management, this soil is highly productive. Practices that protect the soil from erosion and maintain tilth and fertility are necessary. Prevention of overgrazing, weed control, and supplemental irrigation help to maximize forage yields.

A suitable cropping system on this soil includes 5 or 6 years of orchardgrass and white clover for hay and pasture followed by 1 year of oats or 3 years of strawberries. Another cropping system that is suitable uses hay and pasture for 5 or 6 years followed by a row crop or cane fruit for 1 or 2 years. Row crops need to be planted across the slope. The organic matter content can be maintained by using all crop residue and plowing under cover crops.

Most crops respond to fertilizer. Legumes benefit from applications of agricultural lime.

This soil is well suited to the production of Douglas-fir. It is capable of producing annually about 170 cubic feet (CMAI), or about 830 board feet (Scribner rule), per acre. Plant competition prevents adequate restocking, either natural or artificial, without proper site preparation. Tractor logging is the most conventional harvesting method, but it is restricted to the drier months. Windthrow occurs commonly in unmanaged stands.

Because of the seasonal high water table, septic tank drainage fields do not function properly during the wet season. Excavation for basements or utility lines is hazardous. Trenches need to be shored up for safety. Bare soil areas erode unless seeded with a cover crop. Capability subclass IIIe.

20C-Kitsap silt loam, 8 to 15 percent slopes. This sloping soil is moderately well drained. It formed in glacial lake sediments on remnant terraces along Puget Sound and major drainageways. Elevation ranges from 60 to 475 feet. The vegetation is conifers. The annual precipitation is 35 to 50 inches, mean annual air temperature averages about 50 degrees F, and the frost-free season averages about 180 days. In places this soil breaks into deep, narrow drainageways containing other more sloping Kitsap soils. An area of this soil that is more than 200 acres lies on a hillside south of Puyallup.

Included with this soil in mapping are as much as 10 percent Alderwood, Harstine, and Indianola soils. Also included is about 2 percent Bellingham silty clay loam in depressions.

In a typical profile the surface layer is very dark grayish brown and dark brown silt loam about 10 inches thick. The upper part of the subsoil is brown silty clay loam about 7 inches thick. The lower part is mottled, grayish brown silty clay loam about 15 inches thick. The substratum, to a depth of more than 60 inches, is stratified, mottled, light olive brown silt loam and silty clay loam. Reaction is medium acid to neutral.

Permeability is very slow. The available water capacity is high. Few roots penetrate below a depth of 32 inches. Surface runoff is medium, and the erosion. hazard is moderate. The soil is subject to hillside slippage.

This soil is cultivated or in woodland and urban uses. Hay and pasture are the chief crops. Strawberries and cane fruit, principally raspberries, are well suited to this soil. Small stands of cutover alder and Douglas-fir are in the urban-rural fringe areas.

Under good management, this soil is highly productive. Practices that protect the soil from erosion and maintain tilth and fertility are necessary. Prevention of overgrazing, weed control, and supplemental irrigation help to maximize forage yields.

A suitable cropping system on this soil includes 5 or 6 years of orchardgrass and white clover for hay and pasture followed by 1 year of oats or 3 years of strawberries. Row crops need to be planted across the slope. The organic matter content can be maintained by using all crop residue and plowing under cover crops.

Most crops respond to fertilizer. Legumes benefit from applications of agricultural lime.

This soil is well suited to the production of Douglas-fir. It is capable of producing annually about 170 cubic feet (CMAI), or about 830 board feet (Scribner rule), per acre. Plant competition prevents adequate restocking, either natural or artificial, without proper site preparation. Tractor logging is a conventional harvest method, but it is restricted to the drier months. Windthrow is common.

Because of the seasonal high water table, septic drainage fields do not function properly during the wet season. A proper site preparation system that controls runoff, considers the slippage susceptibility, and maintains the esthetic value is necessary. Excavation for basements or utility lines is hazardous. Trenches need to be shored up for safety. Bare soil areas erode unless seeded with a cover crop. Springs or seeps are exposed on cut slopes during roadbuilding. Capability subclass IVe.

20D-Kitsap silt loam, 15 to 30 percent slopes. This moderately steep soil is moderately well drained. It formed in glacial lake sediments in drainageways which originate within areas of other less sloping Kitsap soils. Elevation ranges from 20 to 475 feet. The vegetation is conifers. The annual precipitation is 35 to 50 inches, annual air temperature averages about 50 degrees F, and the frost-free season averages about 180 days. Areas are commonly less than 50 acres in size. In places sloping areas have developed as a result of soil slumping under wet conditions; consequently, a clean, vertical or nearly vertical slope is exposed uphill. Slopes are mainly 18 to 20 percent.

Included with this soil in mapping are as much as 7 percent Alderwood and Harstine gravelly sandy loams, about 3 percent Indianola loamy sand, and as much as 2 percent Bow silt loam.

In a typical profile the surface layer is very dark grayish brown and dark brown silt loam about 10 inches thick. The upper part of the subsoil is brown silty clay loam about 7 inches thick. The lower part is mottled, grayish brown silty clay loam about 15 inches thick. The substratum, to a depth of more than 60 inches, is a stratified, mottled, light olive brown silt loam and silty clay loam. Reaction is medium acid to neutral.

Permeability is very slow. The available water capacity is high. Few roots penetrate below a depth of 32 inches. Surface runoff is medium to rapid, and the erosion hazard is moderate to severe. This soil is subject to hillside slippage.

Most of the acreage of this soil is in cutover woodland. This soil is well suited to the production of Douglas-fir. It is capable of producing annually about 170 cubic feet (CMAI), or about 830 board feet (Scribner rule), per acre. Plant competition prevents adequate restocking, either naturally or artificially, without proper site preparation. Soil losses are minimized by using special erosion control practices and by exercising care in the selection of landings and skidtrails. Springs and seeps are common on cut slopes. Tractor logging is a conventional harvest method, but it is restricted to the drier months. Some windthrown trees can be expected during the winter months when the soil is saturated.

A small area of this soil is cultivated. Hay and pasture are the chief crops. Tree fruits and nuts can be grown. Practices that protect the soil and maintain tilth are necessary. Cross-slope plowing and planting help to check erosion. Prevention of overgrazing and weed control help to maximize forage yields.

A suitable cropping system on this soil includes 5 or 6 years of orchardgrass and white clover for hay and pasture followed by 1 year of oats. Most crops respond to commercial fertilizers. Legumes benefit from applications of agricultural lime.

A proper site preparation system that controls runoff, considers the slippage susceptibility, and maintains the esthetic value is necessary for homesites. Springs or seeps are exposed during site preparation. In areas of moderate population density, the use of onsite sewage disposal systems creates a health hazard. Trenches for utility lines need to be shored up for safety. Capability subclass VIe.

20F-Kitsap silt loam, 30 to 65 percent slopes. This steep and very steep soil is moderately well drained. It formed in glacial lake sediments in drainageways that empty into Puget Sound. Elevation ranges from about sea level to 300 feet. The vegetation is conifers. The annual precipitation is 35 to 50 inches, annual air temperature averages about 50 degrees F, and the frost-free season averages about 180 days. The areas of this soil are adjacent to areas of Kitsap silt loam, 8 to 15 percent slopes, and Indianola loamy sand, 6 to 15 percent slopes.

Included with this soil in mapping are as much as 3 percent Indianola loamy sand and 2 percent deep very fine sandy loam. Vertical escarpments devoid of vegetation are also included.

In a typical profile the surface layer is very dark grayish brown and dark brown silt loam about 10 inches thick. The upper part of the subsoil is brown silty clay loam about 7 inches thick. The lower part is mottled, grayish brown silty clay loam about 15 inches thick. The substratum, to a depth of more than 60 inches, is a stratified, mottled, light olive brown silt loam and silty clay loam. Reaction is medium acid to neutral.

Permeability is very slow. The available water capacity is high. Few roots penetrate below a depth of 32 inches. Surface runoff is rapid to very rapid, and the erosion hazard is severe to very severe. This soil is subject to hillside slippage. Springs and seeps are common.

This soil is used for woodland and open space. It is better suited to these uses than to most others because of the steep slope and the hillside slippage susceptibility.

This soil is suited to the production of Douglas-fir. It is capable of producing annually about 170 cubic feet (CMAI), or about 830 board feet (Scribner rule), per acre. Plant competition prevents adequate restocking, either naturally or artificially, without proper site preparation. The main limitations for timber production are slope, a slowly permeable substratum, and the perched water table during the rainy season in winter and spring. Some windthrown trees can be expected during winter and spring when the soil is saturated. Conventional tree harvest methods are difficult to use. Soil losses are minimized by building roads on more stable soils and by exercising care in the selection of landings and skid trails.

This soil has a limited potential for urban uses because of slope and the slippage susceptibility. In addition, the soil has a perched water table during winter and spring. A few springs are of the artesian type. In most places springs are used for domestic water supplies for beach homes. Capability subclass VIIe.

21F-Kitsap-Indianola complex, 45 to 70 percent slopes. The soils in this complex are very steep and are on dissected terraces along Puget Sound. The silty Kitsap soil is dominant and is on the lower, steeper slopes. The sandy Indianola soil occupies the upper slopes. The Kitsap soil is moderately well drained and formed in glacial lake sediments, and the Indianola soil is somewhat excessively drained and formed in sandy glacial outwash. The vegetation is conifers. Elevation ranges from near sea level to about 300 feet. The annual precipitation is 35 to 50 inches, annual air temperature averages about 50 degrees F, and the frost-free season averages about 180 days.

The Kitsap soil makes up 55 percent of this complex, and the Indianola soil makes up about 30 percent.

Included with this complex in mapping are areas of gently sloping Kitsap soils, steep Harstine soils, Coastal beaches, and very deep fine sandy loam. In areas adjacent to Puget Sound, vertical escarpments devoid of vegetation are also included.

In a typical profile the Kitsap soil has a surface layer of very dark grayish brown and dark brown silty loam about 10 inches thick. The upper part of the subsoil is brown silty clay loam about 7 inches thick. The lower part is mottled grayish brown silty clay loam about 15 inches thick. The substratum, to a depth of more than 60 inches, is a stratified, mottled, light olive brown silty loam and silty clay loam. Reaction is medium acid to neutral.

The Kitsap soil is very slowly permeable. The available water capacity is high. Few roots penetrate below a depth of 32 inches. Surface runoff is very rapid, and the erosion hazard is very severe. This soil is subject to hillside slippage. Springs and seeps are common.

In a typical profile the Indianola soil has a surface layer, 7 inches thick, of dark brown loamy sand. The underlying material, to a depth of more than 60 inches, is dark yellowish brown, brown, or olive brown loamy sand. Reaction is slightly acid or medium acid.

The Indianola soil is rapidly permeable. The available water capacity is low to moderate. Surface runoff is rapid, and the erosion hazard is severe.

These soils are used for watershed, wildlife habitat, open space, and woodland. The very steep slopes and the slippage susceptibility preclude use of these soils for homesites.

These soils are suited to the production of Douglas-fir. A fully stocked stand is difficult to maintain because of slope. In addition, seasonal drought increases seedling losses in areas of Indianola soil. The Kitsap soil is capable of producing annually about 170 cubic feet (CMAI), or 830 board feet (Scribner rule), per acre. The Indianola soil is capable of producing annually 135 cubic feet (CMAI), or 570 board feet (Scribner rule), per acre. Red alder and bigleaf maple become quickly established in open areas of the Kitsap soil. Tree covered slump areas are prominent, particularly in areas of the Kitsap soil. The very steep slopes of this complex hinder the use of conventional tree harvest methods. Erosion control measures are essential because of the severe erosion hazard.

The potential for watershed and woodland wildlife habitat is maintained or increased by limited tree cutting. Runoff is controlled and soil losses minimized by the retention of permanent cover. Capability subclass VIIe.

22A-McKenna gravelly loam. This nearly level McKenna soil is poorly drained. It formed in glacial till under hardwoods, conifers, sedges, and grasses in low-lying depressions and drainageways. Slopes are 0 to 3 percent. All areas of this soil are in the southwestern part of the Area. Elevation ranges from 100 to 700 feet. The annual precipitation is 35 to 45 inches, mean annual air temperature is about 50 degrees F, and the frost-free season is about 165 days.

Included with this soil in mapping are as much as 8 percent Tisch silt, 5 percent Bellingham silty clay loam, and in some areas about 10 percent Dupont muck and Kapowsin gravelly loam.

In a typical profile the surface layer is very dark brown gravelly loam to a depth of 11 inches. The subsoil, to a depth of 18 inches, is dark grayish brown gravelly loam. The substratum, to a depth of 60 inches, is grayish brown gravelly clay loam and grayish brown, mottled gravelly silty clay. Reaction is medium acid.

Permeability is very slow. Few roots penetrate below a depth of 31 inches. The available water capacity is moderate. Surface runoff is very slow and slow. There is no erosion hazard.

This soil is used for pasture and wildlife habitat.

Under good management, this soil is moderately productive. Practices that maintain tilth and fertility are necessary. Drainage can be provided by tile or open ditch methods if outlets are available. Weed control, prevention of overgrazing, and fertilizer help to maximize forage yields.

The organic matter content can be maintained by using all crop residue, plowing under cover crops, and using a suitable cropping system. Where the soil is drained, a typical cropping system includes pasture of orchardgrass and white clover for 5 or 6 years followed by oats for 1 or 2 years. A pasture consisting of meadow foxtail, timothy, big trefoil, and white clover is suitable for undrained areas. Most crops respond to nitrogen, phosphorus, and potassium. Legumes benefit from applications of agricultural lime. Fertilizer needs are best determined by a soil test.

This soil provides excellent habitat for such waterfowl as mallard, pintail, and wood duck.

The poor drainage limits this soil to water-tolerant trees, such as western redcedar and western hemlock. Red alder grows well and is suited to intensive management. The high water table remains close to the surface throughout the rainy season. When the soil is excessively wet and winds are strong, windthrow can be expected. Logging roads constructed on this soil require additional surfacing and drainage; otherwise, the movement of equipment is restricted to the very dry season. Hand planting of Douglas-fir is difficult and the survival rate is very low because of the saturated soil conditions.

This soil is poorly suited to homesites because of the high water table and rainy season ponding. Onsite sewage disposal systems do not function properly. Capability subclass IVw.

23A-National gravelly sandy loam. This nearly level soil is well drained. It formed in volcanic ash and pumice over alluvium and under coniferous trees. The largest area of this soil is on terraces along the Nisqually River. Slopes are mainly 0 to 3 percent, but in some areas they are as much as 4 or 5 percent. Elevation ranges from 1,200 to 2,000 feet. The mean annual precipitation is about 80 inches, mean annual air temperature is about 45 degrees F, and the frost-free season is about 123 days.

Included with this soil in mapping are about 4 percent gently sloping soils and some sloping stony soils on alluvial fans.

In a typical profile the surface layer, to a depth of 10 inches, is very dark grayish brown gravelly sandy loam. The upper part of the subsoil, to a depth of 26 inches, is dark brown gravelly loamy coarse sand and brown gravelly sandy loam. The gravel is pumice fragments 2 to 5 millimeters in size. The lower part of the subsoil, to a depth of 41 inches, is brown loam. The substratum, to a depth of 61 inches, is dark yellowish brown sandy loam and yellowish brown silt loam. Reaction is medium acid.

Permeability is moderate. The available water capacity is high. Surface runoff is slow, and the erosion hazard is slight.

Most of the area of this soil is in woodland. The remainder is used for homesites or pasture.

This soil is suited to the production of Douglas-fir. It is capable of producing annually 185 cubic feet (CMAI), or 960 board feet (Scribner rule), per acre. Tree harvest by conventional methods is feasible anytime during the year. Hand planting of Douglas-fir helps to establish a more uniform stand than natural seeding.

Under good management, this soil is productive. Practices that maintain tilth and fertility are necessary. Prevention of overgrazing, weed control, fertilizer, and supplemental irrigation help to maximize forage yields.

The organic matter content can be maintained by using all crop residue, plowing under cover crops, and using a suitable cropping system. For example, 5 or 6 years of orchardgrass and white clover for hay or pasture and 1 1/2 to 2 years of oats is a suitable cropping system.

Most crops respond to applications of nitrogen, phosphorus, and potassium fertilizers. Legumes benefit from applications of agricultural lime.

Forested areas provide a habitat for black-tailed deer.

This soil is not near highly populated areas, and urban development pressure is minimal. However, along the Nisqually River this soil is used for recreational homesites. Septic tank drainage fields function well throughout the year except for short periods during the rainy season when the substratum is saturated. Capability unit IVs.

24D-Neilton gravelly loamy sand, 8 to 25 percent slopes. This rolling to hilly soil is excessively drained. It formed in stratified, gravelly glacial outwash deposits on uplands. The vegetation is made up of conifers. Elevation ranges from about 100 to 400 feet. The annual precipitation is 35 to 55 inches, and the mean annual air temperature is about 50 degrees F. The frost-free season is about 180 days. Most areas range from 10 acres to about 200 acres in size, but one area of about 450 acres is along Minter Creek west of Purdy.

Included with this soil in mapping are about 4 percent soils that have slopes of more than 25 percent and as much as 10 percent sandy, undulating Indianola soils. Also included in some areas is as much as 5 percent Everett gravelly sandy loam.

In a typical profile a thin mat of undecomposed needles and wood overlies a 3-inch, black gravelly loamy sand surface layer. The subsoil, to a depth of 21 inches, is brown gravelly loamy sand. The substratum, to a depth of more than 60 inches, is stratified layers of clean sand or very gravelly sand. Reaction is neutral to strongly acid.

Permeability is rapid. The available water capacity is low. Surface runoff is slow, and there is a slight erosion hazard. The effective rooting depth is 60 inches.

This soil is used for woodland and urban uses. It is poorly suited to farming.

This soil is suited to the production of Douglas-fir. It is capable of producing annually 165 cubic feet (CMAI), or 760 board feet (Scribner rule), per acre. Trees may be harvested during the rainy season with rubber tire tractors. Hand planting of two-year-old Douglas-fir seedlings helps trees to outgrow brush. This soil is capable of producing moderate amounts of native plants such as salal, evergreen huckleberry, and swordfern.

The primary limitation for urban development is the rolling and hilly slopes. Dwelling and road construction can be designed to reduce the number of cuts and fills. Capability subclass VIs.

25A-Nisqually loamy sand. This nearly level to undulating soil is somewhat excessively drained. It formed in sandy glacial outwash under grass and brackenfern in the Fort Lewis area. Slopes are 2 to 6 percent. Elevation ranges from 200 to about 500 feet. The annual precipitation is 35 to 45 inches, and the mean annual air temperature is about 51 degrees F. The frost-free season is about 170 days. The largest area of this soil is nearly 200 acres and is just south of Roy.

Included with this soil in mapping are areas of Spanaway gravelly sandy loam and about 10 percent Indianola loamy sand. Also included are long, narrow areas of poorly drained Norma fine sandy loam.

In a typical profile the surface layer is 25 inches of black and very dark brown loamy sand. The underlying material, to a depth of more than 60 inches, is dark grayish brown sand. Reaction is slightly acid.

Permeability is rapid. The available water capacity is moderate. Surface runoff is very slow, and the erosion hazard is slight.

This soil is cultivated. Hay and pasture are the chief crops. Strawberries and cane fruit, principally raspberries, are the minor crops.

Under good management, this soil is moderately productive. Practices that maintain tilth and fertility are necessary. Prevention of overgrazing, weed control, fertilizer, and supplemental irrigation help to maximize forage yields.

By using all crop residue, plowing under cover crops, and using a suitable cropping system, the organic matter content can be maintained. A suitable cropping system includes a pasture of orchardgrass and white lover for 5 or 6 years followed by oats for 1 year or strawberries for 3 years.

Most crops respond to nitrogen, phosphorous, and potassium. Legumes benefit from applications of agricultural lime.

This soil is suited to the production of Douglas-fir. It is capable of producing annually 145 cubic feet (CMAI), or 630 board feet (Scribner rule), per acre. This soil has few limitations for timber production except droughtiness, which increases seedling mortality.

This soil can support high density housing if onsite sewage disposal systems are used. The soil is easily excavated. However, trenches for utility lines need to be shored up as a safety precaution. Capability subclass IVs.

26A-Norma fine sandy loam. This nearly level soil is poorly drained. It formed in alluvium under sedges, grasses, conifers, and hardwoods. This soil is on long, narrow stream bottoms and in depressions and on alluvial fans throughout the uplands. Slopes are mainly 0 to 3 percent. Elevation ranges from 50 to 600 feet. The annual precipitation is 35 to 60 inches, mean annual air temperature is about 50 degrees F, and the frost-free season is about 150 to 170 days.

Included with this soil in mapping are small areas of Dupont, McKenna, and Tisch soils.

In a typical profile the surface layer is very dark brown fine sandy loam about 9 inches thick. The subsoil, to a depth of 30 inches, is distinctly mottled, dark grayish brown fine sandy loam. The substratum, to a depth of 71 inches, is mottled, grayish brown sandy loam. In places this soil has an organic surface layer as thick as 5 inches, and in other places it has a gravelly sand substratum. Reaction is medium acid to slightly acid.

Permeability is moderately rapid. Very few roots penetrate below a depth of 48 inches. The available water capacity is high. Surface runoff is very slow or slow. There is no erosion hazard.

This soil is used for pasture and as wildlife habitat.

Under good management, this soil is moderately productive. Practices that maintain tilth and fertility are necessary. Drainage can be provided by tile or open ditch methods if outlets are available. Weed control, prevention of overgrazing, and fertilizer help to maximize forage yields.

The organic matter content can be maintained by using all crop residue, plowing under cover crops, and using a suitable cropping system. Where the soil is drained, a typical cropping system includes pasture of orchardgrass and white clover for 5 or 6 years followed by oats for 1 or 2 years. A pasture consisting of meadow foxtail, timothy, alsike clover, and white clover is suitable for undrained areas.

Most crops respond to nitrogen, phosphorus, and potassium. Legumes benefit from applications of agricultural lime. Fertilizer needs are best determined by a soil test.

This soil provides excellent habitat for such waterfowl as mallard, pintail, and wood duck.

The poor drainage limits this soil to water-tolerant trees, such as western redcedar and western hemlock. Red alder grows well and is suited to intensive management. The high water table remains close to the surface throughout the rainy season. Logging roads constructed on this soil require additional gravel and suitable drainage; otherwise, the movement of equipment is restricted to the very dry season. Hand planting of Douglas-fir is difficult and the survival rate is very low because of the saturated soil conditions.

This soil is poorly suited to use for homesites because of the high water table and rainy season ponding. Onsite sewage disposal systems do not function properly. Capability subclass IIIw.

27A-Orting fine sandy loam. This nearly level soil is somewhat poorly drained. It formed in the Electron mudflow under conifers and hardwoods. Slopes range from 0 to 3 percent. Elevation ranges from 100 to 600 feet. The annual precipitation is 35 to 50 inches, and the mean annual air temperature is about 50 degrees F. The frost-free season is about 180 days.

Included with this soil in mapping is a small area of Orting loam.

In a typical profile the surface layer is very dark brown fine sandy loam about 12 inches thick. The subsoil and substratum, to a depth of more than 60 inches, are distinctly mottled, brown and dark gray gravelly coarse sandy clay loam. Cobbles and stones are scattered throughout the underlying material. Reaction is slightly acid to medium acid.

Permeability is slow. Water ponds above the underlying material. Few roots penetrate below a depth of 30 inches. The available water capacity is high. Surface runoff is very slow, and there is no erosion hazard.

Most of the acreage of this soil is used for row crops and pasture. Daffodil bulbs, strawberries, sweet corn, and carrots are common crops.

Under good management, this soil is highly productive. Practices that maintain tilth and fertility are necessary. Tile drainage can be used if outlets are available. Weed control and supplemental irrigation help to maximize crop yields.

The poor drainage limits this soil to water-tolerant trees, such as western redcedar and western hemlock. Red alder grows well and is suited to intensive management. The high water table remains close to the surface throughout the rainy season. Logging roads constructed on this soil require additional gravel and suitable drainage; otherwise, the movement of equipment is restricted to the very dry season. Hand planting of Douglas-fir is difficult and the survival rate is very low because of the saturated soil condition.

The organic matter content can be maintained by using all crop residue, plowing under green manure crops, and using a suitable cropping system. For example, 2 to 4 ears of strawberries, bulbs, and rhubarb and 2 to 4 years of hay and pasture is a suitable cropping system. Continuous cropping, including annual winter cover crops used as green manure, is also a suitable cropping system. When tulips are grown, a minimum rotation of 5 years is necessary to control fungus.

A soil test best determines fertilizer needs. Most crops respond to commercial fertilizer.

The primary limitation of this soil for urban development is its perched water table. The excess water and the sandy clay loam subsoil limit excavation for homesites to drier months. Tile drainage is necessary to prevent seepage into basements. Community sewerage systems must be used because septic tank drainage fields do not function properly in this slowly permeable and wet soil. Capability subclass IIw.

28A-Orting loam. This nearly level soil is somewhat poorly drained. It formed in the Electron mudflow under conifers and hardwoods. This soil is in areas on the slightly higher plain between the flood plains of the Carbon and Puyallup Rivers. Elevation ranges from 100 to about 600 feet. Slopes are 0 to 3 percent. The annual precipitation is 35 to 50 inches, and the mean annual air temperature is about 50 degrees F. The frost-free season is about 180 days.

Included with this soil in mapping is about 2 percent soils that are similar to this Orting soil but that have numerous stones or pebbles scattered on the surface.

In a typical profile the surface layer, to a depth of 12 inches, is very dark grayish brown loam. The subsoil, to a depth of 24 inches, is distinctly mottled, dark yellowish brown gravelly coarse sandy clay loam. The substratum, to a depth of 69 inches, is distinctly mottled, brown and dark gray gravelly coarse sandy clay loam. Reaction is slightly acid to medium acid. Cobbles and stones are scattered throughout the profile.

Permeability is slow. Water ponds above the compact substratum. Few roots penetrate below a depth of 30 inches. The available water capacity is high. Surface runoff is very slow, and there is no erosion hazard.

Most of the acreage of this soil is used for row crops, pasture, woodland, and homesites. Daffodil bulbs, strawberries, sweet corn, cabbage, and cucumbers are common crops.

Under good management, this soil is highly productive. Practices that maintain tilth and fertility are necessary. Drainage can be provided by tile or open ditch methods if outlets are available. Weed control and supplemental irrigation help to maximize crop yields.

The organic matter content can be maintained by using all crop residue, plowing under green manure crops, and using a suitable cropping system. A suitable cropping system uses 2 to 4 years of strawberries, bulbs, and rhubarb and 2 to 4 years of hay and pasture. Continuous cropping, including annual winter cover crops used as green manure, is also a suitable cropping system. When tulips are grown, a minimum rotation of 5 years is necessary to control fungus.

A soil test best determines fertilizer needs. Most crops respond to commercial fertilizer.

The poor drainage limits this soil to water-tolerant trees, such as western redcedar and western hemlock. Red alder grows well and is suited to intensive management. The high water table remains close to the surface throughout the rainy season. Logging roads constructed on this soil require additional gravel and suitable drainage; otherwise, the movement of equipment is restricted to the very dry season. Hand planting of Douglas-fir is difficult and the survival rate is very low because of the saturated soil conditions.

The primary limitation of this soil for urban development is its perched water table. The excess water and the sandy clay loam subsoil limit excavation for homesites to drier months. Tile drainage is necessary to prevent seepage into basements. Community sewerage systems must be used because septic tank drainage fields do not function properly in this slowly permeable and wet soil. Capability subclass IIw.

29A-Pilchuck fine sand. This nearly level soil is excessively drained. It formed in mixed alluvium under hardwoods and conifers in major river valleys. Elevation ranges from about 20 to 800 feet. Slopes are less than 3 percent. The annual precipitation is 35 to 60 inches, and the mean annual air temperature is about 50 degrees F. The average frost-free season is about 180 days. Most areas are long and narrow. They range from 6 acres to more than 400 acres but average about 75 acres.

Included with this soil in mapping are areas that are as much as 15 percent Aquic Xerofluvents and other areas that are as much as 8 percent Puyallup fine sandy loam.

In a typical profile the surface layer is very dark brown fine sand about 7 inches thick. The underlying material to a depth of 36 inches is very dark brown fine sand, and it is very dark brown very gravelly sand to a depth of 60 inches or more. Reaction is medium acid to neutral.

Permeability is rapid. The effective rooting depth is limited by the very gravelly sand layer. The available water capacity is low. Surface runoff is very slow, and there is no erosion hazard. If unprotected by dikes, this soil is frequently flooded and is subject to moderate streambank erosion.

Much of the acreage of this soil is used for wildlife habitat, pasture, and woodland. Seeded pasture is a common crop.

Under good management, this soil produces fair pasture yields. Low available water capacity, low fertility, and a flooding hazard limit the kinds of crops grown to grasses and legumes for pasture. Prevention of overgrazing and weed control help to maximize forage yields. Supplemental irrigation and fertilizer are essential when this soil is used for row crops.

Grasses respond to nitrogen. Legumes benefit from application of agricultural lime. A soil test best determines fertilizer needs.

This soil is well suited to the production of black cottonwood trees. It is also capable of producing annually 130 cubic feet (CMAI), or 530 board feet (Scribner rule), of Douglas-fir per acre. Conventional methods can be used for tree harvest, but they are restricted to the drier months.

Practices that provide wildlife habitat are difficult to apply and maintain. Low fertility and moisture limit the kind and amount of food grown for wildlife.

The primary limitations for urban development are the flooding hazard in areas that are not diked, seepage from under dikes, runoff from upland areas, and a seasonal high water table. Septic tank effluent from drain fields that moves rapidly through this porous soil may pollute nearby streams. Capability subclass VIw.

30A-Puget silty clay loam. This nearly level soil is poorly drained. It formed in mixed alluvium under hardwoods that are mainly on the flood plains of the Puyallup and White Rivers. Elevation ranges from near sea level to 150 feet. Slopes are less than 2 percent. The surface is slightly concave to flat. The annual precipitation is 35 to 50 inches, and the mean annual air temperature is about 50 degrees F. The average frost-free season is about 190 days.

Included in this soil in mapping are as much as 8 percent Briscot loam and Snohomish silty clay loam.

In a typical profile the surface layer is dark grayish brown silty clay loam about 11 inches thick. The underlying material, to a depth of 24 inches, is mottled, dark grayish brown and grayish brown silty clay loam, and between depths of 24 and more than 60 inches, it is mottled, dark grayish brown silty clay loam and dark gray silt loam. Reaction is slightly acid to strongly acid.

Permeability is slow. In drained areas, root penetration is deep. The available water capacity is high. Surface runoff is very slow, and there is no erosion hazard.

This soil is used for row crops. Rhubarb, bulbs, sweet corn, and pasture are common crops. The perched water table that develops during the rainy season normally limits suitability for deep-rooted crops.

Most of the acreage of this soil is protected from periodic flooding by dikes. However, as land use changes in the nearby upland areas, this soil may be subject to flooding by urban runoff.

Under good management, this soil is highly productive. Practices that maintain tilth and fertility are necessary. Drainage can be provided by tile or open ditch methods if outlets are available. Weed control and supplemental irrigation help to maximize crop yields.

The organic matter content can be maintained by using all crop residue, plowing under green manure crops, and using a suitable cropping system. A suitable cropping system uses 2 to 4 years of strawberries, bulbs, and rhubarb and 2 to 4 years of hay and pasture. Continuous cropping, including annual winter cover crops used as green manure, is also a suitable cropping system. When tulips are grown, a minimum rotation of 5 years is necessary to control fungus.

A soil test best determines fertilizer needs. Most crops respond to commercial fertilizer.

This soil is subject to residential and industrial development pressure. It is well suited to excavation for utility lines. The areas of this soil are protected from periodic flooding by dikes. Onsite sewage disposal systems function improperly or fail during the rainy season because of the high water table. The natural ability of this soil to support large loads is limited. Fill soil material is required for most types of construction. Adequate drainage to dispose of runoff from rooftops and pavement is necessary. Capability subclass IIw.

31A-Puyallup fine sandy loam. This nearly level soil is well drained. It formed in sandy mixed alluvium under trees on the natural levees along the Nisqually and Puyallup Rivers. Elevation ranges from about 20 to 250 feet. Slopes are 0 to 3 percent and are slightly convex. The annual precipitation is 35 to 50 inches, and the mean annual air temperature is about 50 degrees F. The average frost-free season is about 190 days. This soil is between areas of excessively drained Pilchuck soils and somewhat poorly drained Briscot soils or moderately well drained Sultan soils. Areas range in size from 5 acres to more than 300 acres but average about 130 acres.

Included with this soil in mapping are as much as 15 percent Briscot and Pilchuck soils.

In a typical profile the surface layer is very dark brown fine sandy loam about 13 inches thick, The underlying material to a depth of 50 inches is very dark grayish brown loamy fine sand and fine sand. Between depths of 50 and more than 68 inches, it is dark grayish brown fine sandy loam and fine sand. Reaction is slightly acid to neutral.

Permeability is moderately rapid. The effective rooting depth is more than 60 inches. The available water capacity is moderate. Surface runoff is slow, and there is a slight erosion hazard.

A wide range of cultivated crops can be grown on this soil. Daffodil bulbs, raspberries, rhubarb, strawberries, sweet corn, carrots, onions, and pasture axe common crops.

Under good management, this soil is highly productive. Practices that maintain tilth and fertility are necessary. Weed control and supplemental irrigation help to maximize yields.

The organic matter content can be maintained by using all crop residue, plowing under green manure crops, and using a suitable cropping system. A suitable cropping system uses 2 to 4 years of strawberries, bulbs, and rhubarb and 2 to 4 years of hay and pasture. Continuous cropping, including annual winter cover crops used as green manure, is also a suitable cropping system.

A soil test best determines fertilizer needs. Most crops respond to commercial fertilizer.

This soil is subject to residential and industrial development pressure. It is well suited to excavation for utility lines. However, trenches for large utility lines need to be shored up as a safety precaution. During the dry summer months, bare soil areas are subject to some minor soil blowing. Most areas of this soil are protected by dikes. Some areas along the Nisqually River are subject to overflow when the river is at an extremely high water mark. Capability subclass IIs.

32B-Ragnar sandy loam, 0 to 6 percent slopes. This nearly level to undulating soil is well drained. It formed in alluvium under conifers. This soil is on outwash terraces and alluvial fans throughout the uplands. Elevation ranges from 300 to 500 feet. The annual precipitation is 35 to 55 inches, mean annual air temperature is about 50 degrees F, and the frost-free season is about 180 days.

Included with this soil in mapping are small areas of Alderwood, Harstine, and Indianola soils.

In a typical profile the surface layer is a dark yellowish brown sandy loam 7 inches thick. To a depth of 26 inches, the subsoil is brown sandy loam. The substratum, to a depth of 68 inches, is dark grayish brown loamy sand, fine sand, and sand. Reaction is medium acid to slightly acid.

Permeability is moderately rapid. Root penetration is deep. The available water capacity is moderate. Surface runoff is slow, and the erosion hazard is slight.

The soil is used mainly for hay and pasture. It is suited to use as homesites.

Under good management, this soil is moderately productive. Practices that maintain tilth and fertility are necessary. Weed control, prevention of overgrazing, and fertilizer help to maximize forage yields.

The organic matter content can be maintained by using all crop residue, plowing under cover crops, and using a suitable cropping system. A typical cropping system includes a pasture of orchardgrass and white clover for 5 or 6 years followed by oats for 1 year or strawberries for 3 years.

Most crops respond to nitrogen, phosphorus, and potassium. Legumes benefit from applications of agricultural lime. Fertilizer needs are best determined by a soil test.

This soil has few limitations for the production of Douglas-fir, but during long, hot, dry periods, seedlings are subject to stress and losses may be as high as 50 percent. This soil is capable of producing annually 145 cubic feet (CMAI), or 630 board feet (Scribner rule), per acre.

The increase in population and the movement of people from urban to rural areas have resulted in greater residential use of this soil, and it is well suited to excavation for homesites. Septic tank drainage fields function properly throughout the year. Trenches for utility lines need to be shored up for safety. Capability subclass IVs.

32C-Ragnar sandy loam, 6 to 15 percent slopes. This rolling soil is well drained. It formed in alluvium under conifers throughout the uplands. Elevation ranges from 300 to 500 feet. The annual precipitation is 35 to 55 inches, mean annual air temperature is about 50 degrees F, and the frost-free season is about 180 days.

Included with this soil in mapping are small areas of Kitsap and Indianola soils.

In a typical profile the surface layer is very dark yellowish brown sandy loam 7 inches thick. To a depth of 26 inches, the subsoil is brown sandy loam. The substratum, to a depth of 68 inches, is dark grayish brown loamy sand, fine sand, and sand. Reaction is medium acid to slightly acid.

Permeability is moderately rapid. Root penetration is deep. The available water capacity is moderate. Surface runoff is slow or medium, and the erosion hazard is slight or moderate.

This soil is used for hay and pasture.

Under good management, this soil is moderately productive. Practices that reduce erosion and maintain tilth and fertility are necessary. Weed control, prevention of overgrazing, and fertilizer help to maximize forage yields.

The organic matter content can be maintained by using all crop residue, plowing under cover crops, and using a suitable cropping system. A typical cropping system includes a pasture of orchardgrass and white clover for 5 or 6 years followed by oats for 1 year or strawberries for 3 years.

Most crops respond to nitrogen, phosphorus and potassium. Legumes benefit from applications of agricultural lime. Fertilizer needs are best determined by a soil test.

This soil has few limitations for the production of Douglas-fir, but during long, hot, dry periods, seedlings are subject to stress and losses may be as high as 50 percent. Skid trails need to be seeded to minimize soil loss. The soil is capable of producing annually 145 cubic feet (CMAI), or 630 board feet (Scribner rule), per acre.

This soil is suited to use for homesites. It is well suited to excavation. Trenches for utility lines need to be shored up for safety. Bare soil areas erode unless seeded with a cover crop. Septic tank drainage fields function properly throughout the year. Capability subclass IVe.

33A-Reed silty clay. This nearly level soil is poorly drained. It formed in alluvium under sedges, grasses, and hardwoods. This soil is in long, narrow depressions of the Ohop Creek flood plain at elevations ranging from 300 to 500 feet. Slopes are less than 2 percent. The annual precipitation is 45 to 55 inches, and the mean annual air temperature is about 50 degrees F. The average frost-free season is about 160 days.

Included with this soil in mapping are small areas of Chehalis silt loam and Briscot loam, variant.

In a typical profile the surface layer is mottled, dark grayish brown silty clay about 6 inches thick. The underlying material to a depth of 45 inches is mottled, dark grayish brown silty clay and dark gray and grayish brown silty clay loam. To a depth of more than 60 inches, it is mottled, gray, brown, and dark greenish gray silt loam. Reaction is neutral to medium acid.

Permeability is slow. Few roots penetrate below a depth of about 24 inches. The available water capacity is high. Surface runoff is very slow to ponded, and there is little or no erosion hazard. Flooding or ponding occurs several times a year.

This soil is used for pasture and wildlife habitat. Wetness limits the kinds of crops grown.

When this soil is cultivated, careful management is required and conservation practices are difficult to apply and maintain. Tiling to remove excess water and controlling weeds to help maximize forage yields are necessary. In addition, supplemental irrigation may be needed in dry years.

A suitable cropping system on this soil includes a pasture of orchardgrass and white Dutch clover for 5 to 6 years followed by sweet corn for 1 year. Without tiling, permanent pasture is the only suitable crop.

Fertilizer needs are best determined by a soil test. Grasses respond to nitrogen. Legumes benefit from applications of agricultural lime.

This soil is well suited to wetland wildlife habitat. Runoff from nearby uplands helps to maintain a high water table. Seedings of smartweed or proso millet attract waterfowl such as mallards and pintails. Flooding in early fall for waterfowl use is desirable.

Cultivated areas of this soil provide a limited amount of habitat for songbirds and game birds. Shrub hedgerows established along fence lines, roadsides, and streambanks provide resting, nesting, and feeding points.

The flooding hazard and wetness of this soil are limitations that must be considered when planning the construction of homes and roads. Capability subclass IVw.

34A-Riverwash. This unit consists of nearly level bars of recent coarse sand and gravelly alluvium. It is in areas adjacent to perennial and intermittent streams and is flooded by runoff from melting snow and heavy rains. These areas have very sparse vegetative cover consisting of brush and deciduous trees. They are limited to use as wildlife habitat. Capability subclass V IIIw.

35F-Rock outcrop. This miscellaneous area occupies somewhat rounded ridgetops and steep or very steep side slopes and canyon walls in the foothills of the Cascade Mountain Range. Areas consist of as much as 90 percent rock outcrop and 10 to 25 percent shallow soils. In most places the exposed rock is unweathered. Rockfalls are common on very steep slopes and along canyon walls. Areas of this unit provide some protection and some food and water for wildlife. Vegetation is largely moss, lichens, brush, and poorly formed Douglas-fir.

Use of this miscellaneous area is limited to wildlife habitat and watershed purposes. In places, rock is excavated for road ballast. Capability subclass VIIs.

36C-Scamman silt loam, 6 to 15 percent slopes. This sloping soil is somewhat poorly drained. It formed in clayey glacial till under conifers and is dominant in the area south of Eatonville. Elevation ranges from 800 to 2,000 feet. The annual precipitation is 50 to 80 inches, mean annual air temperature is about 50 degrees F, and the frost-free season is about 150 days. Slopes are generally long and smooth. A few large stones break the surface.

Included with this soil in mapping are about 7 percent nearly level to gently sloping soils and about 4 percent poorly drained soils along drainageways.

In a typical profile a mat of undecomposed needles and wood rests upon a 7-inch very dark grayish brown silt loam surface layer. The subsurface layer, to a depth of 14 inches, is dark grayish brown silt loam. The subsoil to a depth of 36 inches, is grayish brown, mottled silty clay. The substratum, to a depth of more than 60 inches, is dark grayish brown silty clay. Reaction is medium acid.

This soil is slowly permeable. Water ponds above the clayey subsoil during the winter and spring rainy period. Few roots penetrate the subsoil. The available water capacity is high. Surface runoff is medium, and the erosion hazard is moderate.

Most of the acreage of this soil is in second growth woodland and pasture. Douglas-fir is the dominant tree.

Under good management, this soil is moderately productive. Practices such as tilling, farming across the slope, and maintaining tilth and fertility are necessary. Prevention of overgrazing, weed control, fertilizer, and supplemental irrigation help to maximize forage yields.

The organic matter content can be maintained by using all crop residue and using a suitable cropping system. For example, a good cropping system includes pasture of orchardgrass and white clover for 5 or 6 years followed by oats for 1 year. Most crops respond to nitrogen, phosphorus, and potassium. Legumes benefit from applications of agricultural lime.

This soil is well suited to the production of Douglas-fir. It is capable of producing annually 160 cubic feet (CMAI), or 730 board feet (Scribner rule), per acre. The primary limitation for timber production is the slowly permeable substratum. During the rainy season, the perched water table remains close to the surface. When the soil is excessively wet and winds are strong, windthrow can be expected. Conventional ground methods can be used for tree harvest, but they are generally restricted to the dry summer months. Because the soil is easily compacted, cable logging is more desirable than tractor logging. Plant competition prevents adequate restocking, either natural or artificial, without adequate site preparation. Hand planting of Douglas-fir helps to establish a more uniform stand than natural seeding.

This soil is not near highly populated areas, and urban development pressure is minimal. The primary limitation to urbanization is the clayey subsoil and the resultant perched water table. Septic tanks function improperly, and community sewerage systems must be used for residential developments. This soil is susceptible, to hillside slippage. Dwelling and road construction can be designed to offset the limited ability of the soil to support a load. Cut slopes weep, and slumping of soil is a concern. Capability subclass IVe.

36D-Scamman silt loam, 15 to 30 percent slopes. This moderately steep soil is somewhat poorly drained. It formed in clayey glacial till under conifers. It is located in the area south of Eatonville. Elevation ranges from 800 to 2,000 feet. The annual precipitation is 50 to 80 inches, mean annual air temperature is about 50 degrees F, and the frost-free season is about 150 days. Slopes are generally long and smooth to somewhat concave. A few large stones break the surface.

Included with this soil in mapping along the Marshel River east of Eatonville are small areas of a soil that formed in glacial lake sediments.

In a typical profile a mat of undecomposed needles and wood overlies a 7-inch very dark grayish brown silt loam surface layer. The subsurface layer, to a depth of 14 inches, is dark grayish brown silt loam. The subsoil, to a depth of 36 inches, is grayish brown, mottled silty clay. The substratum, to a depth of more than 60 inches, is dark grayish brown silty clay. Reaction is medium acid.

This soil is slowly permeable. Water ponds above the clayey subsoil during the winter and spring rainy period. Few roots penetrate the subsoil. The available water capacity is high. Surface runoff is medium to rapid, and the erosion hazard is moderate to severe.

Most of the acreage of this soil is in second growth woodland, and Douglas-fir is the dominant tree.

A small acreage of this soil is cultivated. Extreme care must be taken to control soil loss in cropped fields. Conservation practices, such as farming across the slope and planting to permanent cover crops, are necessary. Prevention of overgrazing, weed control, and fertilizer help to maximize forage yields.

The organic matter content can be maintained by using all crop residue and a suitable cropping system. For example, a good cropping system includes a pasture of orchardgrass and white clover for 5 or 6 years followed by oats for 1 year.

Most crops respond to nitrogen, phosphorus, and potassium. Legumes benefit from applications of agricultural lime. Fertilizer needs to be applied in spring when soil moisture conditions are optimal.

This soil is well suited to the production of Douglas-fir. It is capable of producing annually 160 cubic feet (CMAI), or 730 board feet (Scribner rule), per acre. The primary limitation for timber production is the slowly permeable substratum. During the rainy season, the perched water table remains close to the surface. When the soil is excessively wet and winds are strong, windthrow can be expected. Conventional ground methods can be used for tree harvest, but they are generally restricted to the dry summer months. Because the soil is easily compacted, cable logging is more desirable than tractor logging. Plant competition prevents adequate restocking, either natural or artificial, without adequate site preparation. Red alder becomes quickly established in clear cuts. Hand planting of Douglas-fir helps to establish a more uniform stand than natural seeding.

This soil has poor potential for homesites because of moderately steep slopes, susceptibility to hillside slippage, the clayey subsoil, and the perched water table. Septic tanks function improperly, and community sewerage systems must be used for residential developments. Dwelling and road construction can be designed to offset the limited ability of the soil to support a load. Cut slopes weep, and slumping of the soil is a concern. Capability subclass VIe.

36E-Scamman silt loam, 30 to 45 percent slopes. This steep soil is somewhat poorly drained. It formed in clayey glacial till under conifers. It is adjacent to areas of other less sloping Scamman soils. Elevation ranges from 800 to 2,000 feet. The annual precipitation is 50 to 80 inches, mean annual air temperature is about 50 degrees F, and the frost-free season is about 150 days. Slopes are generally long and slightly concave. A few large stones break the surface.

Included with this soil in mapping are about 5 percent Cinebar silt loam, 30 to 45 percent slopes, and Wilkeson gravelly silt loam, 30 to 45 percent slopes.

In a typical profile a mat of undecomposed needles and wood overlies a 7-inch very dark grayish brown silt loam surface layer. The subsurface layer, to a depth of 14 inches, is dark grayish brown silt loam. The subsoil, to a depth of 36 inches, is grayish brown mottled silty clay. The substratum, to a depth of more than 60 inches, is dark grayish brown silty clay. Reaction is medium acid.

This soil is slowly permeable. Water ponds above the clayey subsoil during the winter and spring rainy period. Few roots penetrate the subsoil. The available water capacity is high. Surface runoff is rapid, and the erosion hazard is severe.

This soil is used for woodland, watershed, and wildlife habitat. It is poorly suited to urban development.

This soil is well suited to the production of Douglas-fir. It is capable of producing annually 160 cubic feet (CMAI), or 730 board feet (Scribner rule), per acre. The primary limitations for timber production are steep slopes, susceptibility to hillside slippage, and a clayey subsoil. During the rainy season, the perched water table remains close to the surface. When the soil is excessively wet and winds are strong, windthrow can be expected. Cable logging is more desirable than tractor logging because this soil is easily compacted. Plant competition prevents adequate restocking, either natural or artificial, without adequate site preparation. Red alder becomes quickly established in clear cuts. Hand planting of Douglas-fir helps to establish a more uniform stand than natural seeding, and it is more suitable for reducing the effects of plant competition. Capability subclass VIIe.

36F-Scamman silt loam, 45 to 70 percent slopes. This very steep soil is somewhat poorly drained. It formed in clayey glacial till under conifers. It consists of a small acreage in the area south of Eatonville. Elevation ranges from 800 to 2,000 feet. The annual precipitation is 50 to 80 inches, mean annual air temperature is about 50 degrees F, and the frost-free season is about 150 days. Slopes are generally long and concave. A few large stones break the surface.

Included with this soil in mapping are 10 percent very steep Wilkeson gravelly silt loam, 4 percent soils that formed in glacial lake sediments, and small areas of exposed bedrock or very shallow soils.

In a typical profile a mat of undecomposed needles and wood overlies a 7-inch very dark grayish brown silt loam surface layer. The subsurface layer, to a depth of 14 inches, is dark grayish brown silt loam. The subsoil, to a depth of 36 inches, is grayish brown, mottled silty clay. The substratum, to a depth of more than 60 inches, is dark grayish brown silty clay. Reaction is medium acid.

This soil is slowly permeable. Water ponds above the clayey subsoil during the winter and spring rainy period. Few roots penetrate the subsoil. The available water capacity is high. Surface runoff is very rapid, and the erosion hazard is very severe.

This soil is used for woodland, watershed, and wildlife habitat. It is poorly suited to urban development.

This soil is suited to the production of Douglas-fir. It is capable of producing annually 160 cubic fee, (CMAI), or 730 board feet (Scribner rule), per acre. The primary limitations for timber production are very steep slopes, susceptibility to hillside slippage, and a clayey subsoil. During the rainy season, the perched water table remains close to the surface. When the soil is excessively wet and winds are strong, windthrow can be expected. Erosion control practices are essential because of the very severe erosion hazard. Plant competition prevents adequate restocking, either natural or artificial, without adequate site preparation. Red alder becomes quickly established in clear cut areas. Hand planting of Douglas-fir helps to establish a more uniform stand than natural seeding, and in places reduces the effects of plant competition. Capability subclass VIIe.

37A-Semiahmoo muck. This level soil is very poorly drained. It formed in decaying sedges, cattails, and reeds in long, narrow backwater depressions of the major river valleys. Slopes are 0 to 1 percent. Elevation ranges from 10 to 300 feet. The annual precipitation is 35 to 50 inches, mean annual air temperature is about 50 degrees F, and the frost-free season is about 190 days.

Included with this soil in mapping is as much as 10 percent Shalcar muck.

In a typical profile the surface layer is black muck 12 inches thick. The underlying material to a depth of 53 inches is black, dark reddish brown, and very dark brown muck. Between depths of 53 and more than 65 inches, it is dark reddish brown peat stratified with very thin layers of dark grayish brown silty clay. Reaction ranges from very strongly acid to slightly acid.

Permeability is moderate. The available water capacity is high. Surface runoff is ponded or very slow, and there is no erosion hazard.

Most of the acreage of this soil is drained and used for truck crops, blueberries, and pasture. Rhubarb, cucumbers, cabbage, lettuce, radishes, and celery are common truck crops.

Under good management, this soil is very productive. Practices that maintain tilth and fertility are necessary. Drainage can be provided by tile or open ditch methods if outlets are available. Weed control, prevention of overgrazing, and fertilizer help to maximize crop yields.

Subsidence is excessive unless the water table is maintained near the surface. Where the soil is drained, a typical cropping system includes a pasture of orchardgrass and white clover for 5 or 6 years followed by oats for 1 or 2 years. Continuous cropping with vegetables, including an annual winter cover crop used as green manure, is also a typical cropping system. A pasture seeding consisting of meadow foxtail, timothy, big trefoil, and white clover is suitable for undrained areas. Deep tillage may be needed occasionally to break up tillage pans.

Most crops respond to nitrogen, phosphorus, and potassium. Legumes benefit from applications of agricultural lime. Fertilizer needs are best determined by a soil test.

This soil provides excellent habitat for waterfowl such as mallard, pintail, and wood duck.

This soil has poor potential for homesites. It is unable to support loads without settling. Filling with soil material or other stabilizing methods are required for construction. Onsite sewage disposal systems function improperly or fail because of the high water table. Capability subclass IIw.

38A-Shalcar muck. This level soil is very poorly drained. It formed in decaying sedges, cattails,, and reeds and in alluvium in long backwater depressions of the major river valleys. Slopes are 0 to 1 percent. Elevation ranges from 120 to 250 feet. The annual precipitation is 35 to 45 inches, mean annual air temperature is about 50 degrees F, and the frost-free season is about 190 days.

Included with this soil in mapping is about 10 percent Semiahmoo muck.

In a typical profile the surface layer is dark reddish brown muck 12 inches thick. The underlying material to a depth of 27 inches is dark grayish brown and dark brown silty clay; between depths of 27 and 46 inches, it is black muck; and between depths of 46 and 64 inches, is very dark gray fine sandy loam. Reaction is slightly acid to very strongly acid.

Permeability is moderately slow. Few roots penetrate below a depth of 48 inches if the soil is drained. The available water capacity is high. Surface runoff is ponded or very slow, and there is no erosion hazard.

Most of the acreage of this soil is drained and used for truck crops, blueberries, and pasture. Rhubarb, cucumbers, cabbage, lettuce, radishes, and celery are common row crops.

Under good management, this soil is very productive. Practices that maintain tilth and fertility are necessary. Drainage can be provided by tile or open ditch methods if outlets are available. Weed control, prevention of overgrazing, and fertilizer help to maximize crop yields.

Subsidence is excessive unless the water table is maintained near the surface. Where the soil is drained, a typical cropping system includes pasture of orchardgrass and white clover for 5 or 6 years followed by oats for 1 or 2 years. Continuous cropping with vegetables, including an annual winter cover crop used as a green manure, is also a typical cropping system. A pasture seeding consisting of meadow foxtail, timothy, big trefoil, and white clover is suitable for undrained areas. Deep tillage may be needed occasionally to break up tillage pans.

Most crops respond to nitrogen, phosphorus, and potassium. Legumes benefit from applications of agricultural lime. Fertilizer needs are best determined by a soil test.

This soil provides excellent habitat for waterfowl such as mallard, pintail, and wood duck.

This soil has poor potential for homesites. It is unable to support any load without settling. Filling with soil material or other stabilizing methods are required for construction. Onsite sewage disposal systems function improperly or fail because of the high water table. Capability subclass IIw.

39A-Snohomish silty clay loam. This nearly level soil is poorly drained. It formed in alluvium and decaying plant remains. These soils are mainly in back areas of the Puyallup and White River valleys. Elevation ranges from 20 to 150 feet. Slopes are 0 to 2 percent. The surface is slightly concave to flat. The annual precipitation is 35 to 45 inches, and the mean annual air temperature is about 50 degrees F. The average frost-free season is about 190 days.

Included with this soil in mapping are about 10 percent Sultan silt loam and Puget silty clay loam.

In a typical profile the surface layer is very dark grayish brown silty clay loam about 9 inches thick. The underlying material to a depth of 17 inches is very dark grayish brown silty clay loam; between depths of 17 and 29 inches, it is dark reddish brown peat and thin strata of mineral material; and between depths of 29 and 80 inches, it is gray and greenish gray silty clay and clay. Reaction is medium acid to neutral.

Permeability is slow. In drained areas root penetration is deep. The available water capacity is high. Surface runoff is very slow, and there is little erosion hazard.

This soil is used for truck crops. Rhubarb, bulbs, cucumbers, cabbage, lettuce, sweet corn, and pasture are common crops. The perched water table that develops during the rainy season normally limits suitability of deep-rooted crops.

Most of the acreage of this soil is protected from periodic flooding by dikes. However, as land use changes in the nearby upland areas, this soil may be subject to flooding by urban runoff.

Under good management, this soil is highly productive. Practices that maintain tilth and fertility are necessary. Drainage can be provided by tile or open ditch methods if outlets are available. Weed and pest controls and supplemental irrigation help to maximize crop yields.

The organic matter content can be maintained by using all crop residue, plowing under green manure crops, and using a suitable cropping system. A suitable cropping system includes 2 to 4 years of strawberries, bulbs, and rhubarb and 2 to 4 years of hay and pasture. Continuous cropping, including annual winter cover crops used as green manure, is also a suitable cropping system. When tulips are grown, a minimum rotation of 5 years is necessary to control fungus. A soil test best determines fertilizer needs. Most crops respond to commercial fertilizer.

This soil is subject to residential and industrial development pressure. It is well suited to excavation for utility lines. Onsite sewage disposal systems function improperly or fail during the rainy season because of the high water table. The natural ability of this soil to support large loads is limited. Fill soil material is required for most construction. Adequate drainage to dispose of runoff from rooftops and pavement is necessary. Capability subclass IIw.

40A-Spana loam. This nearly level soil is somewhat poorly drained. It formed in alluvium containing volcanic ash over very gravelly alluvium in long, narrow depressions of the extensive plain south of Parkland. The vegetation consists of grass and scattered deciduous trees. Elevation ranges from 100 to 500 feet. The annual precipitation is 35 to 45 inches. The mean annual air temperature is about 51 degrees F, and the frost-free season is about 170 days. Slopes range from 0 to 2 percent.

Included with this soil in mapping are small areas of soils that are somewhat excessively drained and are more than 15 percent gravel in the surface layer.

In a typical profile the surface layer is very dark brown loam about 24 inches thick. The subsoil, 5 inches thick, is very dark grayish brown gravelly loam. The substratum, to a depth of 60 inches, is dark grayish brown very gravelly coarse sandy loam and very gravelly loamy sand. Reaction is medium acid.

Permeability is moderate. An apparent water table occurs during the winter and spring rainy season. Very few roots penetrate below a depth of 36 inches. The available water capacity is moderate. Surface runoff is very slow or ponded, and there is no erosion hazard.

Most of the acreage of this soil is in native pasture or is used as wildlife habitat.

Under good management, this soil is moderately productive. Practices that maintain tilth and fertility are necessary. Prevention of overgrazing, weed control, fertilizer, and supplemental irrigation help to maximize forage yields. Drainage in some areas is difficult because of inadequate outlets.

The organic matter content can be maintained by using all crop residue, plowing under cover crops, and using a suitable cropping system. For example, 5 or 6 years of orchardgrass and white clover for hay or pasture and 1 year of oats is a suitable cropping system.

Fertilizer needs are best determined by a soil test. Grasses respond to nitrogen. Legumes benefit from applications of agricultural lime.

This soil is suited to the production of Douglas-fir. It is capable of producing annually 135 cubic feed; (CMAI), or 560 board feet (Scribner rule), per acre. This soil has few restrictions for timber production except during the winter and spring rainy period the water able is at a shallow depth. Seedling survival is low in ponded areas. Hand planting of Douglas-fir seedlings helps to establish a more uniform stand than natural seeding.

The main limitation for urban development is wetness. Septic tank drainage fields fail or do not function properly during the rainy season. This soil is stable when saturated. Capability subclass IVw.

41A-Spanaway gravelly sandy loam. This nearly level to undulating soil is somewhat excessively drained. It formed in glacial outwash mixed in the upper part with volcanic ash on the very extensive plain from Lakewood to Roy. The vegetation is grass and conifers. Elevation ranges from 100 to 500 feet. The annual precipitation is 35 to 45 inches, and the mean annual air temperature is about 51 degrees F. The frost-free season is about 170 days. Slopes range from 0 to 6 percent. In places slopes are short and steep. Areas averaging more than 400 acres in size. Some have stones on the surface.

Included within this soil in mapping is about 8 percent somewhat poorly drained Spana loam in long, narrow depressions. A small area of Nisqually loamy sand is also included.

In a typical profile the surface layer is black gravelly sandy loam 14 inches thick (fig. 14). The subsoil, to a depth of 18 inches, is dark grayish brown very gravelly sandy loam. The substratum, to a depth of more than 60 inches, is light brownish gray very gravelly sand. Reaction is strongly acid to slightly acid.

Permeability is moderately rapid. The available water capacity is low. Surface runoff is slow, and there is little erosion hazard. The effective rooting depth is more than 4 feet.

Large areas of this soil are under native vegetation of grass and conifers.

Because this soil is suitable for onsite sewage disposal systems, much of it is being converted to urban uses, particularly in the Lakewood and Spanaway areas. The remainder is cultivated. Hay and pasture are the chief crops.

Under good management, this soil is moderately productive. Practices that maintain tilth and fertility are necessary. Prevention of overgrazing, weed control, fertilizer, and supplemental irrigation help to maximize forage yields.

The organic matter content can be maintained by using all crop residue, plowing under cover crops, and using a suitable cropping system. For example, 5 or 6 years of orchardgrass and white clover for hay or pasture and 1 year of oats is a suitable cropping system.

Fertilizer needs are best determined by onsite testing. Grasses respond to nitrogen. Legumes benefit from applications of agricultural lime.

This soil is suited to the production of Douglas-fir. It is capable of producing annually 125 cubic feet (CMAI), or 500 board feet (Scribner rule), per acre. This soil has few limitations for timber protection except droughtiness increases seedling mortality. Tree harvest by conventional methods is feasible anytime during the year. Hand planting of Douglas-fir helps to establish a more uniform stand than natural seeding.

This soil has no limitations for urban development. However, septic water from drain fields endangers ground water supplies because the soil is moderately permeable. This soil is suitable as a source of gravel for construction purposes. Few, if any, cuts and fills are needed. Excavation is not difficult. In places large stones are scattered on the surface. Capability subclass IVs.

42A-Sultan silt loam. This nearly level soil is moderately well drained. It formed in alluvium under deciduous and coniferous trees. This soil is on the bottom lands along the Puyallup and White Rivers at elevations ranging from near sea level to 100 feet. Slopes are less than 2 percent, and the surface is smooth. The annual precipitation is 35 to 50 inches, and the mean annual air temperature is about 50 degrees F. The average frost-free season is about 190 days. Areas range in size from 5 to more than 400 acres, but they average about 100 acres. This soil lies between areas of somewhat poorly drained Briscot soils and poorly drained Puget soils.

Included with this soil in mapping are as much as 12 percent Briscot and Puyallup soils on slightly convex slopes and as much as 2 percent Puget soils in troughs or depressions. In the area south of Alderton, small areas of soil underlain by gravelly coarse sandy clay loam at a depth of 18 inches are also included.

In a typical profile the surface layer is dark grayish brown silt loam about 14 inches thick. The underlying material to a depth of 34 inches is mottled, brown silt loam and dark yellowish brown very fine sandy loam. To a depth of more than 60 inches, it is mottled, dark gray fine sandy loam, gray silty clay loam, very (lark grayish brown fine sand, and dark yellowish brown silt loam. Reaction is slightly acid to neutral.

Permeability is moderately slow. In undrained areas, few roots penetrate below a depth of 24 inches. The available water capacity is high. Surface runoff is slow, and there is a slight erosion hazard.

This soil is suitable for a wide range of cultivated crops, and it is one of the better soils for growing row crops. Rhubarb, daffodil bulbs, lettuce, sweet corn, cucumbers, and strawberries are some common crops.

Most of the acreage of this soil is protected from periodic flooding by dikes. However, as a result of changing land use in the nearby upland areas, this soil may be subject to flooding by urban runoff.

Under good management, this soil is highly productive. Practices that maintain tilth and fertility are necessary. Drainage can be provided by tile or open ditch methods if outlets are available. Weed control and supplemental irrigation help to maximize vegetable crop yields. In the Fife area, row crops are irrigated in the latter part of June.

The organic matter content can be maintained by using all crop residue, plowing under green manure crops, and using a suitable cropping system. A suitable cropping system includes 2 to 4 years of strawberries, bulbs, and rhubarb and 2 to 4 years of hay and pasture. Continuous cropping, including annual winter cover crops used as green manure, is also a suitable cropping system. When tulips are grown, a minimum rotation of 5 years is necessary to control fungus.

A soil test best determines fertilizer needs. Most crops respond to commercial fertilizer.

This soil is subject to residential and industrial development pressure. It is well suited to excavation for utility lines. It is protected from periodic flooding by dikes. Onsite sewage disposal systems function improperly or fail during the rainy season because of the high water table. The natural ability of this soil to support large loads is limited. Fill soil material is required for most types of construction. Adequate drainage to dispose of runoff from rooftops and pavement is necessary. Capability subclass IIw.

43A-Tacoma silt loam. This level soil is very poorly drained. It formed in alluvium and decaying plant remains on the deltas of the Nisqually and Puyallup Rivers. The vegetation consists of grasses and sedges. Slopes are 0 to 1 percent. Elevation ranges from sea level to 20 feet. The annual precipitation is 35 to 45 inches, mean annual air temperature is about 50 degrees F, and the frost-free season is about 180 days.

Included with this soil in mapping are diked areas of Hydraquents and some areas of Puget soils.

In a typical profile the surface layer is very dark grayish brown silt loam 4 inches thick. The underlying material to a depth of 23 inches is dark grayish brown silt loam and very dark gray silty clay; between depths of 23 and 59 inches, it is dark gray and light brownish gray silt; and between depths of 59 and 79 inches, it is stratified layers of dark grayish brown silt and partially decomposed organic materials. Reaction is strongly acid.

Permeability is moderately slow. Roots penetrate below a depth of 30 inches. The available water capacity is high. Surface runoff is ponded and there is no erosion hazard.

A large acreage of this soil is used for industrial development. Some areas are diked and used for improved pasture. Areas of this soil that are not diked are used for wetland wildlife habitat. Capability subclass IVw.

44A-Tanwax muck. This level soil is very poorly drained. It formed in sedimentary peat in ponded basins. The vegetation is spirea and grasses. Slopes are 0 to 1 percent. Elevation ranges from 300 to 1,000 feet. The annual precipitation ranges from 35 to 70 inches, mean annual air temperature is about 49 degrees F, and the frost-free season is about 165 days.

Included with this soil in mapping is a small area of Tisch silt.

A typical profile of this soil is very dark grayish brown muck to a depth of 60 inches or more. Reaction is medium acid to strongly acid.

Permeability is moderately slow. Roots extend below a depth of 30 inches. The available water capacity is high. Surface runoff is ponded to very slow, and there is no erosion hazard.

This soil is used in some places for pasture. It provides excellent wildlife habitat for waterfowl such as mallard, pintail, wood duck, and herons and for animals such as beaver and muskrat. Capability subclass IVw.

45A-Tisch silt. This level soil is very poorly drained. It formed mainly in diatomaceous earth, volcanic ash, and decaying plant remains in upland depressions. Slopes are 0 to 1 percent. Elevation ranges from 100 to 1,000 feet. The annual precipitation is 35 to 60 inches, mean annual air temperature is about 50 degrees F, and the frost-free season is about 165 days.

Included with this soil in mapping are about 7 percent Dupont muck, 5 percent McKenna gravelly loam, and in some areas as much as 15 percent a peat soil which extends to a depth of more than 5 feet.

In a typical profile the surface layer is a very dark brown and very dark grayish brown silt 12 inches thick. The underlying material, to a depth of 65 inches, is stratified layers of very dark brown, very dark grayish brown, dark grayish brown, and brown silt and black and very dark brown muck. Reaction is slightly acid and medium acid.

Permeability is moderately slow. Roots penetrate below a depth of 30 inches if the soil is drained. The available water capacity is high. Surface runoff is ponded or very slow, and there is no erosion hazard.

This soil is used for wildlife habitat, and, where drained, it is used for pasture, hops, and blueberries.

Under good management, this soil is productive. Practices that maintain tilth and fertility are necessary. Drainage can be provided by the open ditch method if outlets are available. Weed control, prevention of overgrazing, and fertilizer help to maximize forage yields.

The organic matter content can be maintained by using all crop residue, plowing under cover crops, and using a suitable cropping system. Where the soil is drained, a typical cropping system includes a pasture of orchardgrass and white clover for 5 or 6 years followed by oats for 1 or 2 years. Continuous cropping with vegetables Including an annual winter cover crop used as a green manure is also a suitable cropping system. A pasture seeding consisting of meadow foxtail, timothy, big trefoil, and white clover is suitable for undrained areas.

Most crops respond to nitrogen, phosphorus, and potassium. Legumes benefit from applications of agricultural lime. Fertilizer needs are best determined by a soil test.

This soil provides excellent habitat for waterfowl such as mallard, pintail, and wood duck.

This soil has poor potential for homesites. It is unable to support any load without settling. Fill soil material is required for all types of construction. Onsite sewage disposal systems function improperly or fail because of the high water table. Capability subclass IIIw.

46C-Wilkeson gravelly silt loam, 6 to 15 percent slopes. This sloping soil is well drained. It formed primarily in weathered andesite and basalt under conifers. The soil is located on the lower foothills of the Cascade Range. Elevation ranges from 1,100 to 2,000 feet. The annual precipitation is 70 to 90 inches, mean annual air temperature is about 46 degrees F, and the frost-free season is about 125 days. Slopes are complex and of moderate length.

Included with this soil in mapping is a small area of Scamman silt loam.

In a typical profile a mat of undecomposed needles and wood overlies a very dark grayish brown gravelly silt loam surface layer 4 inches thick. The subsoil, to a depth of 64 inches, is dark brown and brown gravelly silt loam, dark yellowish brown and yellowish brown gravelly silty clay loam, dark yellowish brown loam, and yellowish brown gravelly loam. Reaction is medium acid to strongly acid.

Permeability is moderate. Root penetration is deep. The available water capacity is high. Surface runoff is medium, and the erosion hazard is moderate.

Most of the acreage of this soil is in second growth Douglas-fir. A small area is used for pasture.

This soil is suited to the production of Douglas-fir. It is capable of producing annually 155 cubic feet (CMAI), or 720 board feet (Scribner rule), per acre. It has few limitations for timber production except plant competition, which prevents adequate restocking, either natural or artificial, without proper site preparation.

Under good management, this soil is fairly productive. Practices that reduce erosion and maintain tilth and fertility are necessary. Prevention of overgrazing, weed control, and fertilizer help to maximize forage yields.

The organic matter content can be maintained by using all crop residue, plowing under cover crops, and using a suitable cropping system. For example, 5 or 6 years of orchardgrass and white clover for hay or pasture and 1 1/4 to 2 years of oats or 3 years of strawberries is a suitable cropping system.

Most crops respond to applications of nitrogen, phosphorus, and potassium. Legumes benefit from applications of agricultural lime.

Hand planting of Douglas-fir helps to establish a more uniform stand than natural seeding, and it is more suitable for minimizing the effects of plant competition.

The primary limitation for urban development is slope. Runoff can be controlled and erosion reduced mechanically by planting cover. Grading of the immediate construction area rather than the entire site, intercepting and diverting runoff, and using sediment basins to slow runoff and trap sediment are suitable mechanical measures. Temporary cover crops can be used where cover is needed for several months. Road construction can be designed to offset the inability of the soil to support a load. Cut slopes weep. During the winter and spring rainy season, septic water from onsite sewage disposal units may seep at points farther down the slope. Capability subclass IVe.

46D-Wilkeson gravelly silt loam, 15 to 30 percent slopes. This moderately steep soil is well drained. It formed primarily in weathered andesite and basalt under conifers. The soil is on in the lower foothills of the Cascade Range. Elevation ranges from 1,100 to 2,000 feet. The annual precipitation is 70 to 90 inches, mean annual air temperature is about 46 degrees F, and the frost-free season is about 125 days. Slopes are complex and of moderate length.

Included with this soil in mapping near the town of Wilkeson are small areas of a soil that is underlain by sandstone at a depth of about 30 inches.

In a typical profile a mat of undecomposed needles and wood overlies a very dark grayish brown gravelly silt loam surface layer 4 inches thick. The subsoil, to a depth of 64 inches, is dark brown and brown gravelly silt loam, dark yellowish brown and yellowish brown gravelly silty clay loam, dark yellowish brown loam, and yellowish brown gravelly loam. Reaction is medium acid to strongly acid.

Root penetration is deep. The available water capacity is high. Surface runoff is medium or rapid, and the erosion hazard is moderate or severe.

Most of the acreage of this soil is in second growth Douglas-fir. A small area is used for pasture.

This soil is suited to the production of Douglas-fir. It is capable of producing annually 155 cubic feet (CMAI), or 720 board feet (Scribner rule), per acre. Conventional methods can be used for tree harvest when the soil is dry. On tractor and secondary roads, water bars or culverts can be used to prevent gullying of the roadbed after logging operations. Plant competition prevents adequate restocking either natural or artificial, without proper site preparation. Red alder becomes established in clear cuts. Hand planting of Douglas-fir helps to establish a more uniform stand than natural seeding.

Under good management, this soil is fairly productive. Extreme care must be taken to control erosion in areas of crops. Conservation practices that reduce erosion and maintain tilth and fertility, such as farming across the slope and planting to permanent cover crops, are necessary. Prevention of overgrazing, weed control, and fertilizer help to maximize forage yields.

The organic matter content can be maintained by using all crop residue and using a suitable cropping system. For example, a suitable cropping system includes pasture of orchardgrass and white clover for 5 or 6 years followed by oats for 1 year.

Most crops respond to nitrogen, phosphorus, and potassium. Legumes benefit from applications of agricultural lime. Fertilizer needs to be applied in spring when soil moisture conditions are optimal.

This moderately steep soil has fair potential for homesites. During road construction cuts, arid fills are common. Capability subclass VIe.

46E-Wilkeson gravelly silt loam, 30 to 45 percent slopes. This steep soil is well drained. It formed primarily in weathered andesite and basalt under conifers. The soil is on the lower foothills of the Cascade Range.. Elevation ranges from 1,100 to 2,000 feet. The annual precipitation is 70 to 90 inches, mean annual air temperature is about 46 degrees F, and the frost-free season is about 125 days. Slopes break along drainageways and are long.

Included with this soil in mapping are small amounts of Scamman and Cinebar soils.

In a typical profile a mat of undecomposed needles and wood overlies a very dark grayish brown gravelly silt loam surface layer 4 inches thick. The subsoil to a depth of 64 inches, is dark brown and brown gravelly silt loam, dark yellowish brown and yellowish brown gravelly silty clay loam, and dark yellowish brown and yellowish brown gravelly loam. Reaction is medium acid to strongly acid.

Permeability is moderate. Root penetration is deep. The available water capacity is high. Surface runoff is rapid, and the erosion hazard is severe.

Most of the acreage of this soil is in second growth Douglas-fir. This soil is used for woodland, watershed, and wildlife habitat. It is poorly suited to urban development.

This soil is well suited to the production of Douglas-fir. It is capable of producing annually 155 cubic feet (CMAI), or 720 board feet (Scribner rule) per acre. The primary limitations for timber production are steep slopes and a clayey subsoil. Cable logging is more suitable than tractor logging because this soil is easily compacted. Plant competition prevents adequate restocking, either natural or artificial, without proper site preparation. Red alder becomes quickly established in clear cuts. Hand planting of Douglas-fir helps to establish a more uniform stand than natural seeding, and in places it is more suitable for reducing the effects of plant competition. Capability subclass VIIe.

46F-Wilkeson gravelly silt loam, 45 to 65 percent slopes. This very steep soil is well drained. It formed primarily in weathered andesite and basalt under conifers. The soil is in the lower foothills of the Cascade Range. Elevation ranges from 1,100 to 2,000 feet. The annual precipitation is 70 to 90 inches, mean annual air temperature is about 46 degrees F, and the frost-free season is about 125 days. Slopes break along drainageways and are long.

Included with this soil in mapping near the town of Wilkeson are small amounts of a soil that is underlain by sandstone at a depth of about 30 inches. Andesite outcrops, stony colluvium, and shallow, very gravelly soils on ridge lines are also included.

In a typical profile a mat of undecomposed needles and wood overlies a very dark grayish brown gravelly silt loam surface layer 4 inches thick. The subsoil, to a depth of 64 inches, is dark brown and brown gravelly silt loam, dark yellowish brown and yellowish brown gravelly silty clay loam, dark yellowish brown loam, and yellowish brown gravelly loam. Reaction is strongly acid.

Permeability is moderate. Root penetration is deep. The available water capacity is high. Surface runoff is very rapid, and the erosion hazard is very severe. This soil is susceptible to hillside slippage.

This soil is used for woodland, watershed, and as wildlife habitat. It is poorly suited to urban development. Most of the acreage of this soil is in second growth Douglas-fir.

This soil is suited to the production of Douglas-fir. It is capable of producing annually 155 cubic feet (CMAI), or 720 board feet (Scribner rule), per acre. The primary limitations for timber production are very steep slopes and a clayey subsoil.

Cable logging is more suitable than tractor logging because this soil is very steep and easily compacted. Erosion control methods are essential because of the very severe erosion hazard. Plant competition prevents adequate restocking, either natural or artificial, without adequate site preparation. Red alder becomes quickly established in clear cuts. Hand planting of Douglas-fir helps to establish a more uniform stand than natural seeding, and it is more suitable for reducing the effects of plant competition. Capability subclass VIIe.

47F-Xerochrepts, 45 to 70 percent slopes. These very steep soils are moderately well drained to somewhat excessively drained. They border Puget Sound and the Puyallup and White River valleys. These soils mainly formed in glacial till, but some formed in sandy and gravelly outwash. The vegetation is made up of conifers. Elevation ranges from near sea level to 500 feet. The annual precipitation is 35 to 50 inches, mean annual air temperature is about 50 degrees F, and the frost-free season is about 180 days. Areas are long and narrow on the contour. Most slopes are about 65 percent.

Included with these soils in mapping are small areas of Kitsap-Indianola complex, Coastal beaches, and escarpments devoid of vegetation.

No one profile represents this map unit, but one of the most common ones has a mat of undecomposed needles and wood over a dark yellowish brown gravelly sandy loam surface layer. The subsoil is dark brown, brown, and dark yellowish brown gravelly sandy loam about 40 inches thick. The substratum, to a depth of more than 60 inches, is dark grayish brown and grayish brown gravelly sandy loam and gravelly loamy sand that is weakly cemented at a depth of about 50 inches.

The permeability varies. Runoff is very rapid, and the erosion hazard is very severe. These soils are prominent in tree-covered slump areas.

These soils are used for watersheds, wildlife habitat, and woodland. A fully stocked stand of Douglas-fir is difficult to maintain because of the very steep slope. Nonintensive use of these soils requires limited tree cutting. Capability subclass VIIe.

48A-Xerorthents, fill areas. This unit consists of smoothed areas filled artificially with earth, trash, or both. This unit is most commonly in and around urban areas. A large area is located in Tacoma where wet land has been filled with material dredged from the harbor and subsequently used for industrial and harbor facilities. Capability subclass VIIIs.

Use and management of the soils

The soil survey is a detailed inventory and evaluation of the most basic resource of the survey area the soil. It is useful in adjusting land use, including urbanization, to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in uses of the land.

While a soil survey is in progress, soil scientists, conservationists, engineers, and others keep extensive notes about the nature of the soils and about unique aspects of behavior of the soils. These notes include data on erosion, drought damage to specific crops, yield estimates, flooding, the functioning of septic tank disposal systems, and other factors affecting the productivity, potential, and limitations of the soils under various uses and management. In this way, field experience and measured data on soil properties and performance are used as a basis for predicting soil behavior.

Information in this section is useful in planning use and management of soils for crops and pasture, rangeland, and woodland, as sites for buildings, highways and other transportation systems, sanitary facilities, and parks and other recreation facilities, and for wildlife habitat. From the data presented, the potential of each soil for specified land uses can be determined, soil limitations to these land uses can be identified, and costly failures in houses and other structures, caused by unfavorable soil properties, can be avoided. A site where soil properties are favorable can be selected, or practices that will overcome the soil limitations can be planned.

Planners and others using the soil survey can evaluate the impact of specific land uses on the overall productivity of the survey area or other broad planning area and on the environment. Productivity and the environment are closely related to the nature of the soil. Plans should maintain or create a land-use pattern in harmony with the natural soil.

Contractors can find information that is useful in locating sources of sand and gravel, roadfill, and topsoil. Other information indicates the presence of bedrock, wetness, or very firm soil horizons that cause difficulty in excavation.

Health officials, highway officials, engineers, and many other specialists also can find useful information in this soil survey. The safe disposal of wastes, for example, is closely related to properties of the soil. Pavements, sidewalks, campsites, playgrounds, lawns, and trees and shrubs are influenced by the nature of the soil.

Crops and pasture

HERBERT F. GAINES, district conservationist,. Soil Conservation Service, assisted in preparing this section.

The major management concerns when using the soils for crops and pasture are described in this section. In addition, the crops or pasture plants best adapted to the soil, including some not commonly grown in the survey area, are discussed; the system of land capability classification used by the Soil Conservation Service is explained; and the predicted yields of the main crops, hay, and pasture are presented for each soil.

This section provides information about the overall agricultural potential and needed practices in the survey area for those in the agribusiness sector-equipment dealers, drainage contractors, fertilizer companies, processing companies, planners, conservationists, and others. For each kind of soil, information about management is presented in the section "Soil maps for detailed planning." When making plans for management systems for individual fields or farms, check the detailed information given in the description of each soil.

More than 62,000 acres in the survey area was used for crops and pasture in 1967, according to the Washington Soil and Water Conservation Needs Inventory. Of this total 26,000 acres was used for permanent pasture, 6,500 acres for row crops, 360 acres for close-grown crops, and 12,000 acres for rotation hay and pasture; the rest was hayland and idle cropland.

The potential of the soils in Pierce County Area for increased production of food is fair to poor. About 51,000 acres of potentially good cropland is currently used as woodland and about 13,000 acres as pasture. In addition to the reserve productive capacity of this land, food production could also be increased considerably by extending the latest crop production technology to all cropland in the county. This soil survey can greatly facilitate the application of such technology.

Acreage in crops and pasture has gradually been decreasing as more and more land is used for urban development. It is estimated that in 1967 there was about 36,000 acres of urban and built-up land in the county; this figure has been growing at the rate of about 5,000 acres per year. The use of this soil survey to help make landuse decisions that will influence the future role of farming in the county is discussed in the section "General soil map for broad land use planning."

Soil erosion is a problem on about 6 percent of the cropland and pasture in Pierce County Area. If the slope is more than 2 percent, erosion is a hazard. Bow, Kitsap, and Scamman soils for example, have slopes of 2 to 30 percent or more and an additional limitation of wetness.

Loss of the surface layer through erosion is damaging for. two reasons. First, productivity is reduced as the surface layer is lost and part of the subsoil is incorporated into the plow layer. Loss of the surface layer is especially damaging on soils with a clayey subsoil, such as the Bellingham, Bow, Kitsap, and Scamman soils, and on soils with a layer in or below the subsoil that limits the depth of the root zone. Such layers include duripans, as in Alderwood, Harstine, and Kapowsin soils. Erosion also reduces productivity on soils that tend to be droughty, such as Indianola soils. Second, soil erosion on farm and woodland result in sediment entering streams. Control of erosion minimizes the pollution of streams by sediment and improves quality of water for municipal use, for recreation, and for fish and wildlife.

Erosion control practices provide protective surface cover, reduce runoff, and increase infiltration. A cropping or woodland management system that keeps plant cover on the soil for extended periods can hold soil erosion losses to amounts that will not reduce the productive capacity of the soils. On livestock farms, which require pasture and hay, the legume and grass forage crops in the cropping system reduce erosion on sloping land; they also provide nitrogen and improve tilth for the following crop.

Slopes are so short and irregular that contour tillage or terracing is not practical in the area. The soils are generally not suitable for terracing and diversions, because of irregular slopes, excessive wetness in the terrace channels, a clayey subsoil that would be exposed in terrace channels, or a duripan at a depth of less than 40 inches.

Information on the design of erosion control practices for each kind of soil is available in local offices of the Soil Conservation Service.

Soil drainage is the major management need on about two-thirds of the acreage used for crops and pasture in the survey area. Unless artificially drained, some soils are naturally so wet that the production of crops common to the area is generally not possible. These are the poorly drained and very poorly drained Bellingham, Buckley, Norma, Puget, Snohomish, and Tisch soils, which make up about 21,800 acres in the survey area. Also in this category are the organic soils-Dupont, Semiahmoo, Shalcar, Tacoma, and Tanwax soils-which make up about 8,300 acres.

Without drainage, the somewhat poorly drained soils are so wet that crops are damanaged during most years. In this category are the Briscot, McKenna, Orting, and Sultan soils, which make up about 15,100 acres.

Chehalis and Puyallup soils have good natural drainage most of the year.

The design of both surface and subsurface drainage systems varies with the kind of soil. A combination of surface drainage and tile drainage is needed in most areas of the poorly drained and very poorly drained soils used for intensive row cropping. Drains have to be more closely spaced in soils with slow permeability than in the more permeable soils. Finding adequate outlets for tile drainage systems is difficult in many areas of Bellingham, Buckley, Dupont, McKenna, Norma, Tanwax, and Tisch soils.

Organic soils oxidize and subside when the pore space is filled with air; therefore, special drainage systems are needed to control the depth and the period of drainage. Keeping the water table at the level required by crops during the growing season and raising it to the surface during other parts of the year minimize the oxidation and subsidence of organic soils. Information on drainage design for each kind of soil is available in local offices of the Soil Conservation Service.

Soil fertility is naturally low in most soils of the uplands in the survey area, and all the soils are naturally acid. The soils on the flood plains, such as Briscot, Pilchuck, Puyallup, Snohomish, and Sultan soils, range from strongly acid to neutral and are naturally higher in plant nutrients than most upland soils.

Unless limed, the organic Dupont, Semiahmoo, and Shalcar soils are very strongly acid to slightly acid. These soils require special fertilizers because they are low in copper and other trace elements.

Many uplands soils are naturally very strongly acid and strongly acid, and if they have never been limed, they require applications of ground limestone to raise the pH level sufficiently for good growth of alfalfa and other crops that grow only on nearly neutral soils. Available phosphorus and potash levels are naturally low in most of these soils. On all soils, additions of lime and fertilizer should be based on the results of soils tests, on the need of the crop, and on the expected level of yields. The Cooperative Extension Service can help in determining the kinds and amounts of fertilizer and lime to apply.

Soil tilth is an important factor in the germination of seeds and in the infiltration of water into the soil. Soils with good tilth are granular and porous.

Some of the soils used for crops in the survey area have a silt loam surface layer and are moderate in content of organic matter. Generally the structure of such soils is moderate to strong. Too early plowing of cropland in spring and overuse of equipment, with little or no organic material returned to the soil, tend to develop a massive surface layer that shatters into fragments when plowed rather than into granular or blocky peds. Regular additions of crop residues, manure, and other organic material can help to improve soil structure and to increase infiltration.

The Puget and Snohomish soils are clayey, and tilth is a problem because the soils often stay wet until late in spring. If they are wet when plowed, they tend to be very cloddy when dry and good seedbeds are difficult to prepare. Fall plowing generally results in good tilth in spring.

Field crops suited to the soils and climate of the survey area include few that are not now commonly grown. Potatoes can be grown. Oats, rye, barley, buckwheat, and flax could be grown, and grass seed could be produced from bentgrass, fescue, redtop, and bluegrass.

Specialty crops grown commercially in the survey area are vegetables, small fruits, tree fruits, and nursery plants. Radishes, onions, and lettuce are grown in the large areas of soils in the Puyallup Valley. In addition, a moderate acreage throughout the area is used for rhubarb, strawberries, raspberries, celery, sweet corn, cucumbers, and other vegetables and small fruits. In addition, large areas can be used for other specialty crops such as blueberries and currants. Filberts are the most important tree nuts grown in the county.

Deep soils that have good natural drainage and that warm up early in spring are especially well suited to many vegetables and small fruits. In the survey area these are Indianola and Puyallup soils that have slopes of less than 6 percent, which total about 14,000 acres. Crops can generally be planted and harvested earlier on all these soils than on the other soils in the survey area.

When adequately drained, the muck soils in the area are well suited to a wide range of vegetable crops. Dupont, Semiahmoo, and Shalcar muck soils make up about 8,000 acres in the survey area.

Most of the moderately well drained and well drained soils in the survey area are suitable for orchards and nursery plants. Soils in low positions where frost is frequent and air drainage is poor, however, generally are poorly suited to early vegetables, small fruits, and orchards.

Yields per acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 2. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors. Absence of an estimated yield indicates that the crop is not suited to or not commonly grown on the soil or that a given crop is not commonly irrigated.

The estimated yields were based mainly on the experience and records of farmers, conservationists, and extension agents. Results of field trials and demonstrations and available yield data from nearby counties were also considered.

The yields were estimated assuming that the latest soil and crop management practices were used. Hay and pasture yields were estimated for the most productive varieties of grasses and legumes suited to the climate and the soil. A few farmers may be obtaining average yields higher than those shown in table 2.

The management needed to achieve the indicated yields of the various crops depends on the kind of soil and the crop. Such management provides drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate tillage practices, including time of tillage and seedbed preparation and tilling when soil moisture is favorable; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residues, barnyard manure, and green-manure crops; harvesting crops with the smallest possible loss; and timeliness of all fieldwork.

For yields of irrigated crops, it is assumed that the irrigation system is adapted to the soils and to the crops grown; that good quality irrigation water is uniformly applied in proper amounts as needed; and that tillage is kept to a minimum.

The estimated yields reflect the productive capacity of the soils for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 2 are grown in the survey area, but estimated yields are not included because the acreage of these crops is small. The local offices of the Soil Conservation Service and the Cooperative Extension Service can provide information about the management concerns and productivity of the soils for these crops.

Capability classes and subclasses

Capability classes and subclasses show, in a general way, the suitability of soils for most kinds of field crops. The soils are classed according to their limitations when they are used for field crops, the risk of damage when they are used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to rice, cranberries, horticultural crops, or other crops that require special management. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for forest trees, or for engineering purposes.

In Pierce County Area, all kinds of soil are grouped at two levels of the capability system: capability class and subclass. Capability class and subclass are defined in the following paragraphs. A survey area may not have soils of all classes.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants, or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants, or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class V I soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and landforms have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class; they are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and c, used in only some parts of the United States, shows that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion, though they have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

The capability subclass is identified in the description of each soil mapping unit in the section "Soil maps for detailed planning."

Woodland management and productivity

GARY R. NORDSTROM, forestry specialist, Soil Conservation Service, assisted in preparing this section.

Approximately two-thirds of Pierce County, Area is woodland. About 65 percent of this acreage is privately owned. Some of the woodland areas are being held for residential and recreational sites and for investment purposes. The soils of the county have a high potential for production of wood crops. The management of the woodland is quite varied, ranging from very intensive management to no management at all.

Logs are sold for processing into a variety of wood products, including dimension lumber, furniture, pulp, plywood, utility poles, piling, shakes and shingles, and fenceposts. Large quantities of logs are also used for fireplace wood. There are several large and a number of small wood processing plants located in the area.

Although the native stands of trees were primarily conifers, a significant acreage is presently deciduous. Douglas-fir is the dominant conifer; western hemlock and western redcedar grow in smaller but significant numbers. The dominant deciduous tree is red alder, and there are small stands of bigleaf maple growing in association with the other principal timber types. Black cottonwoods grow near streams and in wet depressional soils. Red alder commonly invades areas and becomes dominant unless intensive management is applied or unless soil conditions are unfavorable for its establishment.

Table 3 contains information useful to woodland owners or forest managers planning use of soils for wood crops. Map unit symbols for soils suitable for wood crops are listed, and the ordination (woodland suitability) symbol for each soil is given. All soils bearing the same ordination symbol require the same general kinds of woodland management and have about the same potential productivity.

The first part of the *ordination symbol,* a number, indicates the potential productivity of the soils for important trees. The number 1 indicates very high productivity; 2, high; 3, moderately high; 4, moderate; and 5, low. The second part of the symbol, a letter, indicates the major kind of soil limitation. The letter *x* indicates stoniness or rockiness; *w*, excessive water in or on the soil; *t*, toxic substances in the soil; *d,* restricted root depth; *c*, clay in the upper part of the soil; *s*, sandy texture; *f*, high content of coarse fragments in the soil profile; and *r*, steep slopes. The letter o indicates insignificant limitations or restrictions. If a soil has more than one limitation, priority in placing the soil into a limitation class is in the following order: x, w, t, d, c, s, f, and r.

In table 3 the soils are also rated for a number of factors to be considered in management. *Slight, moderate,* and *severe* are used to indicate the degree of major soil limitations.

Ratings of *equipment limitation* reflect the characteristics and conditions of the soil that restrict use of the equipment generally needed in woodland management or harvesting. A rating of *slight* indicates that use of equipment is not limited to a particular kind of equipment or time of year; *moderate* indicates a short seasonal limitation or a need for some modification in management or equipment; and *severe* indicates a seasonal limitation, a need for special equipment or management, or a hazard in the use of equipment.

Seedling mortality ratings indicate the degree that the soil affects expected mortality of planted tree seedlings. Plant competition is not considered in the ratings. Seedlings from good planting stock that are properly planted during a period of sufficient rainfall are rated. A rating of *slight* indicates that the expected mortality of the planted seedlings is less than 25 percent; *moderate,* 25 to 50 percent; and *severe,* more than 50 percent.

Considered in the ratings of *windthrow hazard* are characteristics of the soil that affect the development of tree roots and the ability of the soil to hold trees firmly. A rating of *slight* indicates that trees in wooded areas are not expected to be blown down by commonly occurring winds; *moderate,* that some trees are blown down during periods of excessive soil wetness and strong winds; and *severe,* that many trees are blown down during periods of excessive soil wetness and moderate or strong winds.

Ratings of *plant competition* indicate the degree to which undesirable plants are expected to invade or grow if openings are made in the tree canopy. The invading plants compete with native plants or planted seedlings by impeding or preventing their growth. A rating of *slight* indicates little or no competition from other plants; *moderate* indicates that plant competition is expected to hinder the development of a fully stocked stand of desirable trees; and *severe* means that plant competition is expected to prevent the establishment of a desirable stand unless the site is intensively prepared, weeded, or otherwise managed for the control of undesirable plants.

The *potential productivity* of merchantable or *important trees* on a soil is expressed as *a site index (5).* This index is the average height, in feet, that dominant and codominant trees of a given species attain in a specified number of years. The site index applies to fully stocked, even-aged, unmanaged stands. Important trees are those that woodland managers generally favor in intermediate or improvement cuttings. They are selected on the basis of growth rate, quality, value, and marketability.

Trees to plant are those that are suitable for commercial wood production and that are suited to the soils.

Engineering

ALVIN R. SCHMIDT, engineer, Soil Conservation Service, assisted in preparing this section.

This section provides information about the use of soils for building sites, sanitary facilities, construction material, and water management. Among those who can benefit from this information are engineers, landowners, community planners, town and city managers, land developers, builders, contractors, and farmers.

The ratings in the engineering tables are based on test data and estimated data in the "Soil properties" section. The ratings were determined jointly by soil scientists and engineers of the Soil Conservation Service using known relationships among the soil properties and the behavior of soils in various engineering uses.

Among the soil properties and site conditions identified by a soil survey and used in determining the ratings in this section were grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock that is within 5 or 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure or aggregation, in-place soil density, and geologic origin of the soil material. Where pertinent, data about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of absorbed cations were also considered.

On the basis of information assembled about soil properties, ranges of values can be estimated for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, shear strength, compressibility, slope stability, and other factors of expected soil behavior in engineering uses. As appropriate, these values can be applied to each major horizon of each soil or to the entire profile.

These factors of soil behavior affect construction and maintenance of roads, airport runways, pipelines, foundations for small buildings, ponds and small dams, irrigation projects, drainage systems, sewage and refuse disposal systems, and other engineering works. The ranges of values can be used to (1) select potential residential, commercial, industrial, and recreational uses; (2) make preliminary estimates pertinent to construction in a particular area; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for location of sanitary landfills, onsite sewage disposal systems, and other waste disposal facilities; (5) plan detailed onsite investigations of soils and geology; (6) find sources of gravel, sand, clay, and topsoil; (7) plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; (8) relate performance of structures already built to the properties of the kinds of soil on which they are built so that performance of similar structures on the same or a similar soil in other locations can be predicted; and (9) predict the trafficability of soils for cross-country movement of vehicles and construction equipment.

Data presented in this section are useful for land-use planning and for choosing alternative practices or general designs that will overcome unfavorable soil properties and minimize soil-related failures. Limitations to the use of these data, however, should be well understood. First, the data are generally not presented for soil material below a depth of 5 or 6 feet. Also, because of the scale of the detailed map in this soil survey, small areas of soils that differ from the dominant soil may be included in mapping. Thus, these data do not eliminate the need for onsite investigations, testing, and analysis by personnel having expertise in the specific use contemplated.

The information is presented mainly in tables. Table 4 shows, for each kind of soil, the degree and kind of limitations for building site development; table 5, for sanitary facilities; and table 7, for water management. Table 6 shows the suitability of each kind of soil as a source of construction materials.

The information in the tables, along with the soil map, the soil descriptions, and other data provided in this survey, can be used to make additional interpretations and to construct interpretive maps for specific uses of land.

Some of the terms used in this soil survey have a special meaning in soil science. Many of these terms are defined in the Glossary.

Building site development

The degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, and local roads and streets are indicated in table 4. A *slight* limitation indicates that soil properties generally are favorable for the specified use; any limitation is minor and easily overcome. A *moderate* limitation indicates that soil properties and site features are unfavorable for the specified use, but the limitations can be overcome or minimized by special planning and design. A *severe* limitation indicates that one or more soil properties or site features are so unfavorable or difficult to overcome that a major increase in construction effort, special design, or intensive maintenance is required. For some soils rated severe, such costly measures may not be feasible.

Shallow excavations are made for pipelines, sewerlines, communications and power transmission lines, basements, open ditches, and cemeteries. Such digging or trenching is influenced by soil wetness caused by a seasonal high water table; the texture and consistence of soils; the tendency of soils to cave in or slough; and the presence of very firm, dense soil layers, bedrock, or large stones. In addition, excavations are affected by slope of the soil and the probability of flooding. Ratings do not apply to soil horizons below a depth of 6 feet unless otherwise noted.

In the soil series descriptions, the consistence of each soil horizon is given, and the presence of very firm or extremely firm horizons, usually difficult to excavate, is indicated.

Dwellings and *small commercial buildings* referred to in table 4 are built on undisturbed soil and have foundation loads of a dwelling no more than three stories high. Separate ratings are made for small commercial buildings without basements and for dwellings with and without basements. For such structures, soils should be sufficiently stable that cracking or subsidence of the structure from settling or shear failure of the foundation does not occur. These ratings were determined from estimates of the shear strength, compressibility, and shrink-swell potential of the soil. Soil texture, plasticity and in-place density, potential frost action, soil wetness, and depth to a seasonal high water table were also considered. Soil wetness and depth to a seasonal high water table indicate potential difficulty in providing adequate drainage for basements, lawns, and gardens. Depth to bedrock, slope, and large stones in or on the soil are also important considerations in the choice of sites for these structures and were considered in determining the ratings. Susceptibility to flooding is a serious hazard.

Local roads and streets referred to in table 4 have an all-weather surface that can carry light to medium traffic all year. They consist of a subgrade of the underlying soil material; a base of gravel, crushed rock fragments, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly asphalt or concrete. The roads are graded with soil material at hand, and most cuts and fills are less than 6 feet deep.

The load supporting capacity and the stability of the soil as well as the quantity and workability of fill material available are important in design and construction of roads and streets. The classifications of the soil and the soil texture, density, shrink-swell potential, and potential frost action are indicators of the traffic supporting capacity used in making the ratings. Soil wetness, flooding, slope, depth to hard rock or very compact layers, and content of large stones affect stability and ease of excavation.

Sanitary facilities

Favorable soil properties and site features are needed for proper functioning of septic tank absorption fields, sewage lagoons, and sanitary landfills. The nature of the soil is important in selecting sites for these facilities and in identifying limiting soil properties and site features to be considered in design and installation. Also, those soil properties that affect ease of excavation or installation of these facilities will be of interest to contractors and local officials. Table 5 shows the degree and kind of limitations of each soil for such uses and for use of the soil as daily cover for landfills. It is important to observe local ordinances and regulations.

If the degree of soil limitation is expressed as *slight,* soils are generally favorable for the specified use and limitations are minor and easily overcome; if *moderate,* soil properties or site features are unfavorable for the specified use, but limitations can be overcome by special planning and design; and if *severe,* soil properties or site features are so unfavorable or difficult to overcome that major soil reclamation, special designs, or intensive maintenance is required. Soil suitability is rated by the terms *good, fair,* or *poor,* which, respectively, mean about the same as the terms *slight, moderate,* and *severe.*

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into the natural soil. Only the soil horizons between depths of 18 and 72 inches are evaluated for this use. The soil properties and site features considered are those that affect the absorption of the effluent and those that affect the construction of the system.

Properties and features that affect absorption of the effluent are permeability, depth to seasonal high water table, depth to bedrock, and susceptibility to flooding. Stones, boulders, and shallowness to bedrock interfere with installation. Excessive slope can cause lateral seepage and surfacing of the effluent. Also, soil erosion and soil slippage are hazards if absorption fields are installed on sloping soils.

In some soils, loose sand and gravel or fractured bedrock is less than 4 feet below the tile lines. In these soils the absorption field does not adequately filter the effluent, and ground water in the area may be contaminated.

On many of the soils that have moderate or severe limitations for use as septic tank absorption fields, a system to lower the seasonal water table can be installed or the size of the absorption field can be increased so that performance is satisfactory.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons have a nearly level floor and cut slopes or embankments of compacted soil material. Aerobic lagoons generally are designed to hold sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water. Soils that are very high in content of organic matter and those that have cobbles, stones, or boulders are not suitable. Unless the soil has very slow permeability, contamination of ground water is a hazard where the seasonal high water table is above the level of the lagoon floor. In soils where the water table is seasonally high, seepage of ground water into the lagoon can seriously reduce the lagoon's capacity for liquid waste. Slope, depth to bedrock, and susceptibility to flooding also affect the suitability of sites for sewage lagoons or the cost of construction. Shear strength and permeability of compacted soil material affect the performance of embankments.

Sanitary landfill is a method of disposing of solid waste by placing refuse in successive layers either in excavated trenches or on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil material. Landfill areas are subject to heavy vehicular traffic. Risk of polluting ground water and trafficability affect the suitability of a soil for this use. The best soils have a loamy or silty texture, have moderate to slow permeability, are deep to a seasonal water table, and are not subject to flooding. Clayey soils are likely to be sticky and difficult to spread. Sandy or gravelly soils generally have rapid permeability, which might allow noxious liquids to contaminate ground water. Soil wetness can be a limitation, because operating heavy equipment on a wet soil is difficult. Seepage into the refuse increases the risk of pollution of ground water.

Ease of excavation affects the suitability of a soil for the trench type of landfill. A suitable soil is deep to bedrock and free of large stones and boulders. If the seasonal water table is high, water will seep into trenches.

Unless otherwise stated, the limitations in table 5 apply only to the soil material within a depth of about 6 feet. If the trench is deeper, a limitation of slight or moderate may not be valid. Site investigation is needed before a site is selected.

Daily cover for landfill should be soil that is easy to excavate and spread over the compacted fill in wet and dry periods. Soils that are loamy or silty and free of stones or boulders are better than other soils. Clayey soils may be sticky and difficult to spread; sandy soils may be subject to soil blowing.

The soils selected for final cover of landfills should be suitable for growing plants. Of all the horizons, the A horizon in most soils has the best workability, more organic matter, and the best potential for growing plants. Thus, for either the area- or trench-type landfill, stockpiling material from the A horizon for use as the surface layer of the final cover is desirable.

Where it is necessary to bring in soil material for daily or final cover, thickness of suitable soil material available and depth to a seasonal high water table in soils surrounding the sites should be evaluated. Other factors to be evaluated are those that affect reclamation of the borrow areas. These factors include slope, erodibility, and potential for plant growth.

Construction materials

The suitability of each soil as a source of roadfill, sand, gravel, and topsoil is indicated in table 6 by ratings of good, fair, or poor. The texture, thickness, and organic-matter content of each soil horizon are important factors in rating soils for use as construction materials. Each soil is evaluated to the depth observed, generally about 6 feet.

Roadfill is soil material used in embankments for roads. Soils are evaluated as a source of roadfill for low embankments, which generally are less than 6 feet high and less exacting in design than high embankments. The ratings reflect the ease of excavating and working the material and the expected performance of the material where it has been compacted and adequately drained. The performance of soil after it is stabilized with lime or cement is not considered in the ratings, but information about some of the soil properties that influence such performance is given in the descriptions of the soil series.

The ratings apply to the soil material between the A horizon and a depth of 5 to 6 feet. It is assumed that soil horizons will be mixed during excavation and spreading. Many soils have horizons of contrasting suitability within their profile. The estimated engineering properties in table 10 provide specific information about the nature of each horizon. This information can help determine the suitability of each horizon for roadfill.

Soils rated *good* are coarse grained. They have low shrink-swell potential, low potential frost action, and few cobbles and stones. They are at least moderately well drained and have slopes of 15 percent or less. Soils rated *fair* have a plasticity index of less than 15 and have other limiting features, such as moderate shrink-swell potential, moderately steep slopes, wetness, or many stones. If the thickness of suitable material is less than 3 feet, the entire soil is rated *poor.*

Sand and *gravel* are used in great quantities in many kinds of construction. The ratings in table 6 provide guidance as to where to look for probable sources and are based on the probability that soils in a given area contain sizable quantities of sand or gravel. A soil rated *good* or *fair* has a layer of suitable material at least 3 feet thick, the top of which is above a depth of 6 feet. Coarse fragments of soft bedrock material, such as shale and siltstone, are not considered to be sand and gravel. Fine-grained soils are not suitable sources of sand and gravel.

The ratings do not take into account depth to the water table or other factors that affect excavation of the material. Descriptions of grain size, kinds of minerals, reaction, and stratification are given in the soil series descriptions and in table 10.

Topsoil is used in areas where vegetation is to be established and maintained. Suitability is affected mainly by the ease of working and spreading the soil material in preparing a seedbed and by the ability of the soil material to support plantlife. Also considered is the damage that can result at the area from which the topsoil is taken.

The ease of excavation is influenced by the thickness of suitable material, wetness, slope, and amount of stones. The ability of the soil to support plantlife is determined by texture, structure, and the amount of soluble salts or toxic substances. Organic matter in the A1 or Ap horizon greatly increases the absorption and retention of moisture and nutrients. Therefore, the soil material from these horizons should be carefully preserved for later use.

Soils rated *good* have at least 16 inches of friable loamy material at their surface. They are free of stones and cobbles, are low in content of gravel, and have gentle slopes. They are low in soluble salts that can limit or prevent plant growth. They are naturally fertile or respond well to fertilizer. They are not so wet that excavation is difficult during most of the year.

Soils rated *fair* are loose sandy soils or firm loamy or clayey soils in which the suitable material is only 8 to 16 inches thick or soils that have appreciable amounts of gravel, stones, or soluble salt.

Soils rated *poor* are very sandy soils and very firm clayey soils; soils with suitable layers less than 8 inches thick; soils having large amounts of gravel, stones, or soluble salt; steep soils; and poorly drained soils.

Although a rating of *good* is not based entirely on high content of organic matter, a surface horizon is generally preferred for topsoil because of its organic-matter content. This horizon is designated as A1 or Ap in the soil series descriptions. The absorption and retention of moisture and nutrients for plant growth are greatly increased by organic matter.

Water management

Many soil properties and site features that affect water management practices have been identified in this soil survey. In table 7 the soil and site features that affect use are indicated for each kind of soil. This information is significant in planning, installing, and maintaining water control structures.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have a low seepage potential, which is determined by permeability and the depth to fractured or permeable bedrock or other permeable material.

Embankments, dikes, and levees require soil material that is resistant to seepage, erosion, and piping and has favorable stability, shrink-swell potential, shear strength, and compaction characteristics. Large stones and organic matter in a soil downgrade the suitability of a soil for use in embankments, dikes, and levees.

Drainage of soil is affected by such soil properties as permeability; texture; depth to bedrock, hardpan, or other layers that affect the rate of water movement; depth to the water table; slope; stability of ditchbanks; susceptibility to flooding; salinity and alkalinity; and availability of outlets for drainage.

Irrigation is affected by such features as slope, susceptibility to flooding, hazards of water erosion and soil blowing, texture, presence of salts and alkali, depth of root zone, rate of water intake at the surface, permeability of the soil below the surface layer, available water capacity, need for drainage, and depth to the water table.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to intercept runoff. They allow water to soak into the soil or flow slowly to an outlet. Features that affect suitability of a soil for terraces are uniformity and steepness of slope; depth to bedrock, hardpan, or other unfavorable material; large stones; permeability; ease of establishing vegetation; and resistance to water erosion, soil blowing, soil slipping, and piping.

Grassed waterways are constructed to channel runoff to outlets at a nonerosive velocity. Features that affect the use of soils for waterways are slope, permeability, erodibility, wetness, and suitability for permanent vegetation.

Recreation

The soils of the survey area are rated in table 8 according to limitations that affect their suitability for recreation uses. The ratings are based on such restrictive soil features as flooding, wetness, slope, and texture of the surface layer. Not considered in these ratings, but important in evaluating a site, are location and accessibility of the area, size and shape of the area and its scenic quality, the ability of the soil to support vegetation, access to water, potential water impoundment sites available, and either access to public sewerlines or capacity of the soil to absorb septic tank effluent. Soils subject to flooding are limited, in varying degree, for recreation use by the duration and intensity of flooding and the season when flooding occurs. Onsite assessment of height, duration, intensity, and frequency of flooding is essential in planning recreation facilities.

The degree of the limitation of the soils is expressed as slight, moderate, or severe. *Slight* means that the soil properties are generally favorable and that the limitations are minor and easily overcome. *Moderate* means that the limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 8 can be supplemented by information in other parts of this survey. Especially helpful are interpretations for septic tank absorption fields, given in table 5, and interpretations for dwellings without basements and for local roads and streets, given in table 4.

Camp areas require such site preparation as shaping and leveling for tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils for this use have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing camping sites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for use as picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that will increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones or boulders, is firm after rains, and is not dusty when dry. If shaping is required to obtain a uniform grade, the depth of the soil over bedrock or hardpan should be enough to allow necessary grading.

Paths and trails for walking, horseback riding, bicycling, and other uses should require little or no cutting and filling. The best soils for this use are those that are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once during the annual period of use. They should have moderate slopes and have few or no stones or boulders on the surface.

Wildlife habitat

In the late 1700's and early 1800's much of Pierce County Area was covered with climax coniferous forest. Most wildlife inhabited the forested edges along waterways and shorelines and openings resulting from wind or fire.

During the mid-1800's settlers moved into the area and began farming and logging. These activities created additional openings in the forest, allowing understory plants to thrive. The interspersion of forests with croplands, grasslands, water, and native herbaceous vegetation allowed wildlife populations to prosper. However, increased human numbers, accompanied by industrial and urban development, has subsequently eliminated or altered many areas of food, water, or cover that are necessary to sustain optimum wildlife populations.

Soils directly affect the kind and amount of vegetation that is available to wildlife as food and cover, and they affect the construction of water impoundments. The kind and abundance of wildlife that populate an area depend largely on the amount and distribution of food, cover, and water. If any one of these elements is missing, is inadequate, or is inaccessible, wildlife either are scarce or do not inhabit the area.

If the soils have the potential, wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by helping the natural establishment of desirable plants.

In table 9, the soils in the survey area are rated according to their potential to support the main kinds of wildlife habitat in the area. This information can be used in planning for parks, wildlife refuges, nature study areas, and other developments for wildlife; selecting areas that are suitable for wildlife; selecting soils that are suitable for creating, improving, or maintaining specific elements of wildlife habitat; and determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* means that the element of wildlife habitat or the kind of habitat is easily created, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected if the soil is used for the designated purpose. A rating of *fair* means that the element of wildlife habitat or kind of habitat can be created, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* means that limitations are severe for the designated element or kind of wildlife habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* means that restrictions for the element of wildlife habitat or kind of wildlife are very severe, and that unsatisfactory results can be expected. Wildlife habitat is impractical or even impossible to create, improve, or maintain on soils having such a rating.

The elements of wildlife habitat are briefly described in the following paragraphs.

Grain and seed crops are seed-producing annuals used by wildlife. The major soil properties that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, oats, and barley.

Grasses and legumes are domestic perennial grasses and herbaceous legumes that are planted for wildlife food and cover. Major soil properties that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, lovegrass, bromegrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds, that provide food and cover for wildlife. Major soil properties that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, goldenrod, beggarweed, wheatgrass, and grama.

Coniferous plants are cone-bearing trees, shrubs, or ground cover plants that furnish habitat or supply food in the form of browse, seeds, or fruitlike cones. Soil properties that have a major effect on the growth of coniferous plants are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are pine, spruce, fir, cedar, and juniper.

Shrubs are bushy woody plants that produce fruit, buds, twigs, bark, or foliage used by wildlife or that provide cover and shade for some species of wildlife. Major soil properties that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and moisture. Examples of shrubs are mountain-mahogany, bitterbrush, snowberry, and big sagebrush.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites, exclusive of submerged or floating aquatics. They produce food or cover for wildlife that use wetland as habitat. Major soil properties affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, wildrice, saltgrass, and cordgrass and rushes, sedges, and reeds.

Shallow water areas are bodies of water that have an average depth of less than 5 feet and that are useful to wildlife. They can be naturally wet areas, or they can be created by dams or levees or by water-control structures in marshes or streams. Major soil properties affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. The availability of a dependable water supply is important if water areas are to be developed. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The kinds of wildlife habitat are briefly described in the following paragraphs.

Openland wildlife habitat consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The kinds of wildlife attracted to these areas include bobwhite quail, pheasant, meadowlark, field sparrow, cottontail rabbit, and red fox.

Woodland wildlife habitat consists of areas of hardwoods or conifers, or a mixture of both, and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include wild turkey, ruffed grouse, woodcock, thrushes, woodpeckers, squirrels, gray fox, raccoon, deer, and bear.

Wetland wildlife habitat consists of open, marshy or swampy, shallow water areas where water-tolerant plants grow. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, muskrat, mink, and beaver.

Soil properties

Extensive data about soil properties are summarized on the following pages. The two main sources of these data are the many thousands of soil borings made during the course of the survey and the laboratory analyses of selected soil samples from typical profiles.

In making soil borings during field mapping, soil scientists can identify several important soil properties. They note the seasonal soil moisture condition or the presence of free water and its depth. For each horizon in the profile, they note the thickness and color of the soil material; the texture, or amount of clay, silt, sand, and gravel or other coarse fragments; the structure, or the natural pattern of cracks and pores in the undisturbed soil; and the consistence of the soil material in place under the existing soil moisture conditions. They record the depth of plant roots, determine the pH, or reaction, of the soil, and identify any free carbonates.

Samples of soil material are analyzed in the laboratory to verify the field estimates of soil properties and to determine all major properties of key soils, especially properties that cannot be estimated accurately by field observation. Laboratory analyses are not conducted for all soil series in the survey area, but laboratory data for many soil series not tested are available from nearby survey areas.

The available field and laboratory data are summarized in tables. The tables give the estimated range of engineering properties, the engineering classifications, and the physical and chemical properties of each major horizon of each soil in the survey area. They also present data about pertinent soil and water features.

Engineering properties

Table 10 gives estimates of engineering properties and classifications for the major horizons of each soil in the survey area.

Most soils have, within the upper 5 or 6 feet, horizons of contrasting properties. Table 10 gives information for each of these contrasting horizons in a typical profile. *Depth* to the upper and lower boundaries of each horizon is indicated. More information about the range in depth and about other properties in each horizon is given for each soil series in the section "Soil series and morphology"

Texture is described in table 10 in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in soil material that is less than 2 millimeters in diameter. "Loam," for example, is soil material that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If a soil contains gravel or other particles coarser than sand, an appropriate modifier is added, for example, "gravelly loam." Other texture terms are defined in the Glossary.

The two systems commonly used in classifying soils for engineering use are the Unified soil classification system (Unified) (2) and the system adopted by the American Association of State Highway and Transportation Officials (AASHTO) (1).

The *Unified* system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter, plasticity index, liquid limit, and organic-matter content. Soils are grouped into 15 classes-eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; six classes of fine-grained soils, identified as ML, CL, OL, MH, CH, and OH; and one class of highly organic soils, identified as Pt. Soils on the borderline between two classes have a dual classification symbol, for example, CLML.

The *AASHTO* system classifies soils according to those properties that affect their use in highway construction and maintenance. In this system a mineral soil is classified in one of seven basic groups ranging from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines. At the other extreme, in group A-7, are fine-grained soils. Highly organic soils are classified in group A-8 on the basis of visual inspection.

Also in table 10 the percentage, by weight, of rock fragments more than 3 inches in diameter is estimated for each major horizon. These estimates are determined mainly by observing volume percentage in the field and then converting that, by formula, to weight percentage.

Percentage of the soil material less than 3 inches in diameter that passes each of four sieves (U.S. standard) is estimated for each major horizon. The estimates are based on tests of soils that were sampled in the survey area and in nearby areas and on field estimates from many borings made during the survey.

Liquid limit and *plasticity index* indicate the effect of water on the strength and consistence of soil. These indexes are used in both the Unified and AASHTO soil classification systems. They are also used as indicators in making general predictions of soil behavior. Range in liquid limit and plasticity index are estimated on the basis of test data from the survey area or from nearby areas and on observations of the many soil borings made during the survey.

In some surveys, the estimates are rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterburg limits extend a marginal amount across classification boundaries (1 or 2 percent), the classification in the marginal zone is omitted.

Physical and chemical properties

Table 11 shows estimated values for several soil characteristics and features that affect behavior of soils in engineering uses. These estimates are given for each major horizon, at the depths indicated, in the typical pedon of each soil. The estimates are based on field observations and on test data for these and similar soils.

Permeability is estimated on the basis of known relationships among the soil characteristics observed in the field-particularly soil structure, porosity, and gradation or texture-that influence the downward movement of water in the soil. The estimates are for vertical water movement when the soil is saturated. Not considered in the estimates is lateral seepage or such transient soil features as plowpans and surface crusts. Permeability of the soil is an important factor to be considered in planning and designing drainage systems, in evaluating the potential of soils for septic tank systems and other waste disposal systems, and in many other aspects of land use and management.

Available water capacity is rated on the basis of soil characteristics that influence the ability of the soil to hold water and make it available to plants. Important characteristics are content of organic matter, soil texture, and soil structure. Shallow-rooted plants are not likely to use the available water from the deeper soil horizons. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design of irrigation systems.

Soil reaction is expressed as a range in pH values. The range in pH of each major horizon is based on many field checks. For many soils, the values have been verified by laboratory analyses. Soil reaction is important in selecting the crops, ornamental plants, or other plants to be grown; in evaluating soil amendments for fertility and stabilization; and in evaluating the corrosivity of soils.

Shrink-swell potential depends mainly on the amount and kind of clay in the soil. Laboratory measurements of the swelling of undisturbed clods were made for many soils. For others the swelling was estimated on the basis of the kind and amount of clay in the soil and on measurements of similar soils. The size of the load and the magnitude of the change in soil moisture content also influence the swelling of soils. Shrinking and swelling of some soils can cause damage to building foundations, basement walls, roads, and other structures unless special designs are used. A high shrink-swell potential indicates that special design and added expense may be required if the planned use of the soil will not tolerate large volume changes.

Risk of corrosion pertains to potential soil-induced chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to soil moisture, particle-size distribution, total acidity, and electrical conductivity of the soil material. The rate of corrosion of concrete is based mainly on the sulfate content, texture, and acidity of the soil. Protective measures for steel or more resistant concrete help to avoid or minimize damage resulting from the corrosion. Uncoated steel intersecting soil boundaries or soil horizons is more susceptible to corrosion than an installation that is entirely within one kind of soil or within one soil horizon.

Erosion factors are used to predict the erodibility of a soil and its tolerance to erosion in relation to specific kinds of land use and treatment. The soil erodibility factor (K) is a measure of the susceptibility of the soil to erosion by water. Soils having the highest K values are the most erodible. K values range from 0.10 to 0.64. To estimate annual soil loss per acre, the K value of a soil is modified by factors representing plant cover, grade and length of slope, management practices, and climate. The soil-loss tolerance factor (T) is the maximum rate of soil erosion, whether from rainfall or soil blowing, that can occur without reducing crop production or environmental quality. The rate is expressed in tons of soil loss per acre per year.

Soil and water features

Table 12 contains information helpful in planning land uses and engineering projects that are likely to be affected by soil and water features.

Flooding is the temporary covering of soil with water from overflowing streams, with runoff from adjacent slopes, and by tides. Water standing for short periods after rains or after snow melts is not considered flooding, nor is water in swamps and marshes. Flooding is rated in general terms that describe the frequency and duration of flooding and the time of year when flooding is most likely. The ratings are based on evidence in the soil profile of the effects of flooding, namely thin strata of gravel, sand, silt, or, in places, clay deposited by floodwater; irregular decrease in organic-matter content with increasing depth; and absence of distinctive soil horizons that form in soils of the area that are not subject to flooding. The ratings are also based on local information about floodwater levels in the area and the extent of flooding; and on information that relates the position of each soil on the landscape to historic floods.

The generalized description of flood hazards is of value in land-use planning and provides a valid basis for landuse restrictions. The soil data are less specific, however, than those provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table is the highest level of a saturated zone more than 6 inches thick for a continuous period of more than 2 weeks during most years. The depth to a seasonal high water table applies to undrained soils. Estimates are based mainly on the relationship between grayish colors or mottles in the soil and the depth to free water observed in many borings made during the course of the soil survey. Indicated in table 12 are the depth to the seasonal high water table; the kind of water table, that is, perched, artesian, or apparent; and the months of the year that the water table commonly is high. Only saturated zones above a depth of 5 or 6 feet are indicated.

Information about the seasonal high water table helps in assessing the need for specially designed foundations, the need for specific kinds of drainage systems, and the need for footing drains to insure dry basements. Such information is also needed to decide whether or not construction of basements is feasible and to determine how septic tank absorption fields and other underground installations will function. Also, a seasonal high water table affects ease of excavation.

Depth to bedrock is shown for all soils that are underlain by bedrock at a depth of 5 to 6 feet or less. For many soils, the limited depth to bedrock is a part of the definition of the soil series. The depths shown are based on measurements made in many soil borings and on other observations during the mapping of the soils. The kind of bedrock and its hardness as related to ease of excavation is also shown. Rippable bedrock can be excavated with a single-tooth ripping attachment on a 200-horsepower tractor, but hard bedrock generally requires blasting.

Cemented pans are hard subsurface layers, within a depth of 5 or 6 feet, that are strongly compacted (indurated). Such pans cause difficulty in excavation. The hardness of pans is similar to that of bedrock. A rippable pan can be excavated, but a hard pan generally requires blasting.

Soil series and morphology

In this section, each soil series recognized in the survey area is described in detail. The descriptions are arranged in alphabetic order by series name.

Characteristics of the soil and the material in which it formed are discussed for each series. The soil is then compared to similar soils and to nearby soils of other series. Then a pedon, a small three-dimensional area of soil that is typical of the soil series in the survey area, is described. The detailed descriptions of each soil horizon follow standards in the Soil Survey Manual (7). Unless otherwise noted, colors described are for moist soil.

Following the pedon description is the range of important characteristics of the soil series in this survey area. Phases, or map units, of each soil series are described in the section "Soil maps for detailed planning."

Alderwood series

The Alderwood series consists of moderately well drained soils that formed in glacial till. Alderwood soils are on uplands and have slopes of 0 to 30 percent. The mean annual precipitation is about 35 inches, and the mean annual air temperature is about 50 degrees F.

Typical pedon of Alderwood gravelly sandy loam, 6 to 15 percent slopes, 1,008 feet south and 384 feet east of the northwest corner of section 8, T. 20 N., R. 5 E.:

O1-1 1/2 inches to 3/4 inch; needles, leaves, bark, and wood fragments.

O2-3/4 inch to 0; black (10YR 2/1) partially decomposed needles, leaves, and wood, dark gray (10YR 4/1) dry; abrupt smooth boundary.

A1cn-0 to 1 1/2 inches; very dark grayish brown (10YR 3/2) gravelly sandy loam, grayish brown (10YR 5/2) dry; weak fine and medium granular structure; soft, very friable, slightly sticky and slightly plastic; common roots; 30 percent iron concentrations and fine gravel; medium acid (pH 5.6); abrupt smooth boundary. (1 to 2 inches thick)

B2cn-1 1/2 to 7 inches; dark yellowish brown (10YR 3/4) gravelly sandy loam, brown (10YR 5/3) dry; weak fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common roots; 45 percent iron concretions and fine gravel; medium acid (pH 5.8); clear smooth boundary. (4 to 6 inches thick)

B3cn-7 to 16 inches; brown (10YR 4/3) gravelly sandy loam, yellowish brown (10YR 5/4) dry; weak fine and medium subangular blocky structure; slightly hard, very friable, slightly sticky and nonplastic; common roots; 40 percent iron concretions and fine gravel; medium acid (pH 5.8); abrupt wavy boundary. (7 to 9 inches thick)

C1-16 to 38 inches; dark grayish brown (2.5Y 4/2) gravelly sandy loam, light brownish gray (2.5Y 6/2) dry; common fine distinct yellowish brown (10YR 5/6) streaks; massive; hard, firm; common roots to a depth of 24 inches, few roots between depths of 24 and 38 inches; 45 percent gravel; medium acid (pH 5.8); abrupt wavy boundary. (12 to 23 inches thick)

C2sim-38 to 60 inches; dark yellowish brown (2.5Y 4/2) gravelly sandy loam, light brownish gray (2.5Y 6/2) dry; massive; weakly cemented; very hard, extremely firm; medium acid (pH 5.8); abrupt wavy boundary.

The A1 horizon has hue of 10YR, value of 3, and chroma of 2 or 3 moist. The B2 horizon has hue of 10YR, value of 3 or 4, and chroma of 4 moist. These horizons are dominantly gravelly sandy loam. The C horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 to 4. The depth to the weakly cemented C2sim horizon is 30 to 40 inches.

The control section is 35 to 45 percent coarse fragments. This horizon is very hard or extremely hard.

Barneston series

The Barneston series consists of somewhat excessively drained soils that formed in glacial outwash derived from andesite, granite, sandstone, basalt, quartzite, and schist. Barneston soils are on uplands and have slopes of 0 to 45 percent. The mean annual precipitation is 45 to 70 inches, and the mean annual air temperature is about 49 degrees F.

Typical pedon of Barneston gravelly coarse sandy loam, 6 to 15 percent slopes, 2,500 feet east and 1,600 feet north of southwest corner of section 33, T. 19 N., R. 6 E.:

O2-1 1/4 inches to 0; black (10YR 2/1) decomposed organic matter; soft, very friable, nonsticky and nonplastic; no roots; extremely acid (pH 4.2); abrupt smooth boundary. (3/4 inch to 1 1/2 inches thick)

A1-0 to 2 inches; very dark brown (10YR 2/2) gravelly coarse sandy loam, dark grayish brown (10YR 4/2) dry; weak very fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; many fine to coarse roots; extremely acid (pH 4.4); abrupt smooth boundary. (0 to 2 inches thick)

A3-2 to 5 inches; very dark grayish brown (10YR 3/2) gravelly coarse sandy loam, grayish brown (10YR 512) dry; weak very fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; many fine to coarse roots; very strongly acid (pH 4.8); clear smooth boundary. (0 to 3 inches thick)

B2-5 to 13 inches; dark yellowish brown (10YR 3/4) gravelly coarse sandy loam, brown (10YR 5/3) dry; weak fine subangular blocky structure; soft, friable, nonsticky and nonplastic; many fine to coarse roots; strongly acid (pH 5.2); clear smooth boundary. (6 to 8 inches thick)

C1-13 to 60 inches; brown (10YR 4/3) very gravelly sand, yellowish brown (10YR 5/4) dry; single grained; loose, few fine to coarse roots; medium acid (pH 5.8); clear wavy boundary.

Coarse fragments make up 50 to 80 percent of the control section. The A horizon has hue of 10YR, value of 2 or 3 moist and 4 or 5 dry, and chroma of 1 or 2. The B horizon has hue of 10YR or 7.5YR, value of 3 or 4 moist and 5 or 6 dry, and chroma of 3 or 4. The A and B horizons range from gravelly coarse sandy loam to gravelly loamy sand. The C horizon has hue of 10YR or 2.5Y, value of 5 or 6 dry, and chroma of 2 through 4 moist and 2 through 4 dry. It is stratified with sand and gravelly sand.

Bellingham series

The Bellingham series consists of poorly drained soils that formed in alluvium. Bellingham soils are on the glacial till plain and have slopes of 0 to 3 percent. The mean annual precipitation is 35 to 45 inches, and the mean annual air temperature is about 50 degrees F.

Typical pedon of Bellingham silty clay loam, 2,800 feet west and 550 feet south of northeast corner of section 8, T. 18 N., R. 1 E.:

Ap-0 to 4 inches; very dark grayish brown (10YR 3/2) silty clay loam, light brownish gray (10YR 5/2) dry; few fine faint strong brown (7.5YR 5/8) mottles; weak fine granular structure; hard, firm, sticky and plastic; many very fine roots; few very fine and fine pores; few fine distinct manganese stains; distinct pressure faces or peds; slightly acid (pH 6.4); clear smooth boundary. (4 to 6 inches thick)

B21g-4 to 11 inches; brown (2.5Y 5/2) clay, very pale brown (2.5Y 7/2) dry; many medium prominent yellowish brown (10YR 5/6) mottles; moderate medium prismatic structure; very hard, very firm, very sticky and very plastic; common very fine roots; common very fine and fine pores; slightly acid (pH 6.4); clear smooth boundary. (6 to 8 inches thick)

B22g-11 to 60 inches; dark grayish brown (2.5Y 4/2) clay, light brownish gray (2.5Y 6/2) dry; few fine distinct greenish gray (5G 6/1) mottles; massive structure; very hard, very firm, very sticky and very plastic; very few very fine roots; neutral (pH 6.8).

The Ap horizon has hue of 10YR, value of 2 or 3 moist and 4 through 6 dry, and chroma of 1 or 2 moist or dry. The B21g horizon has hue of 2.5Y, 5BG, 5GY, or 5Y; value of 5 through 7; and chroma of 1 or 2. It has many yellowish brown (10YR 5/8 and 5/6) and strong brown (7.5YR 5/6) mottles. The B22g horizon has a hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 2. It has few, fine, greenish gray (5G 6/1, 5GY 6/1, and 5BG 6/1) mottles.

Bow series

The Bow series consists of somewhat poorly drained soils that formed in lake sediments over glacial till. Bow soils are on benches and have slopes of 2 to 30 percent. The mean annual precipitation is 30 to 50 inches, and the mean annual air temperature is about 50 degrees F.

Typical pedon of Bow silt loam, 8 to 15 percent slopes, 2,300 feet east and 200 feet south of the northeast corner of section 7, T. 19 N., R. 1 E., on Anderson Island:

O1-1 inch to 0; undecomposed needles and twigs; abrupt smooth boundary. (1/2 inch to 1 1/2 inches thick)

A1-0 to 2 inches; very dark brown (10YR 2/2) silt loam, grayish brown (10YR 5/2) dry; moderate medium granular structure; slightly hard, firm, sticky and plastic; common fine to medium roots; 5 percent gravel and nodules; slightly acid (pH 62); abrupt smooth boundary. (1 inch to 3 inches thick)

A2-2 to 7 inches; dark grayish brown (10YR 4/2) silty clay loam, light gray (10YR 7/2) dry; moderate fine and medium subangular blocky structure; hard, firm, very sticky and plastic; common fine to medium roots; few very fine pores; less than 5 percent gravel; medium acid (pH 5.8); clear smooth boundary. (3 to 7 inches thick)

B&A-7 to 26 inches; the A2 portion of the horizon is dark grayish brown (10YR 4/2) silty clay loam, occupies 10 to 15 percent of the horizon, and is 1 to 3 millimeters wide on ped surfaces. The B portion is grayish brown (2.5YR 5/2) silty clay and light brownish gray (2.5YR 7/2) clay; many medium prominent strong brown (7.5YR 5/6) mottles; moderate fine subangular blocky structure parting to moderate very thin platy; very hard, firm, very sticky and plastic; few very fine roots along vertical ped faces; few very fine and fine pores; thick continuous clay films in pores; less than 5 percent gravel; medium acid (pH 5.8); clear wavy boundary. (10 to 20 inches thick)

B2tg-26 to 34 inches; grayish brown (2.5Y 5/2) sandy clay, light gray (2.5Y 7/2) dry; many medium prominent strong brown (7.5YR 5/6) mottles along horizontal planes; massive; very hard, firm, sticky and plastic; few very fine roots; patchy clay films; slightly acid (pH 6.2); gradual wavy boundary. (7 to 10 inches thick)

IIC-34 to 60 inches; dark grayish brown (10YR 4/2) gravelly loam, light brownish gray (10YR 6/2) dry; massive; very hard, friable, slightly sticky and slightly plastic; 15 to 25 percent gravel; slightly acid (pH 6.2).

Coarse fragments make up less than 15 percent of the upper part of the profile and from 15 to 25 percent of the lower part.

The A1 horizon has value of 2 or 3 moist, 4 through 6 dry, and chroma of 2 or 3. It is silt loam, loam, or clay loam. The A2 horizon has value of 3 or 4 moist, 6 or 7 dry, and chroma of 1 or 2 moist or dry. It is silt loam, clay loam, or silty clay loam. The B&A horizon is mottled with strong brown and yellowish brown. The B portion has hue of 10YR or 2.5Y and value of 4 or 5 moist and 6 through 8 dry. It is silty clay or clay. The B2tg horizon has hue of 2.5Y or l0YR and value of 5 through 8 dry. The B2tg horizon has strong brown or yellowish brown mottles. It is sandy clay loam, sandy clay, or silty clay loam. The IIC horizon has colors similar to those of the B horizon. It is loam, silty clay loam, sandy clay, or silty clay.

Briscot series

The Briscot series consists of somewhat poorly drained soils that formed in alluvium. Briscot soils are on flood plains of the Puyallup and Stuck River valleys. Slopes are 0 to 2 percent. The mean annual precipitation is 35 to 50 inches, and the mean annual air temperature is about 50 degrees F.

Typical pedon of Briscot loam, 1,320 feet east and 943 feet north of the southwest corner of section 30, T. 20 N., R. 5 E.:

Ap1-0 to 6 inches; dark brown (10YR 3/3) loam, brown (10YR 5/3) dry; weak very fine and fine subangular blocky structure; slightly hard, friable, nonsticky and slightly plastic; common roots; medium acid (pH 6.0); clear smooth boundary. (6 to 8 inches thick)

Ap2-6 to 11 inches; dark brown (10YR 4/3) loam, brown (10YR 5/3) dry; moderate medium subangular blocky structure; slightly hard, friable, nonsticky and slightly plastic; common roots; few very fine pores; slightly acid (pH 6.2); abrupt smooth boundary. (4 to 6 inches thick)

C1g-11 to 15 inches; dark grayish brown (10YR 4/2) fine sandy loam, grayish brown (10YR 5/2) dry; common fine distinct. yellowish red (5YR 4/6) mottles; weak medium subangular blocky structure; soft, very friable, nonsticky and slightly plastic; common roots; few very fine pores; slightly acid (pH 6.2); abrupt smooth boundary. (4 to 6 inches thick)

C2g-15 to 29 inches; dark grayish brown (10YR 4/2) silt loam, pale brown (10YR 6/3) dry; common fine distinct yellowish red (5YR 4/6) mottles; moderate medium subangular blocky structure; hard, firm, sticky and plastic; few roots; many very fine and few fine pores; moderately thick dark reddish brown (5YR 3/3) silt deposits in pores; slightly acid (pH 6.4); abrupt smooth boundary. (14 to 16 inches thick)

C3g-29 to 38 inches; very dark grayish brown (10YR 3/2) medium sand, grayish brown (10YR 5/2) dry; common fine distinct yellowish red (5YR 4/6) mottles; single grained; loose, very friable, nonsticky and nonplastic; very few roots; neutral (pH 6.8); abrupt smooth boundary. (8 to 10 inches hick)

C4g-38 to 58 inches; gray (10YR 5/1) silty clay loam, light gray (10YR 7/2) dry; common fine distinct yellowish red (5YR 4/6) and yellowish brown (10YR 5/6) mottles; massive; very hard, very firm, very sticky and very plastic; common very fine and few fine pores; thick dark reddish brown (5YR 3/4) silty deposits in pores; neutral (pH 6.8); abrupt smooth boundary. (18 to 22 inches thick)

C5g-58 to 65 inches; very dark grayish brown (10YR 3/2) sand, grayish brown (10YR 5/2) dry; common fine distinct yellowish red (5YR 4/6) mottles; single grained; loose, very friable, nonsticky and nonplastic; slightly acid (pH 6.4).

The Ap horizon has chroma of 2 or 3 moist or dry and is loam or very fine sandy loam. It has granular or blocky structure. The C horizon has value of 3 through 5 moist and 5 through 7 dry. Mottles range in hue from 2.5YR through 10YR and in chroma from 2 to 6. The C horizon may contain layers of loamy fine sand, very fine sand, loam, and silty clay in the upper part.

Briscot variant

The Briscot variant consists of moderately well drained soils that formed in alluvium. These soils are on flood plains along South Prairie and Ohop Creeks. Slopes range from 0 to 3 percent. The mean annual precipitation is 35 to 50 inches, and the mean annual air temperature is about 50 degrees F.

Typical pedon of Briscot loam, variant, 2,895 feet west and 1,362 feet south of northwest corner of section 23, T. 19 N., R. 5 E.:

Ap-0 to 6 inches; dark brown (10YR 3/3) loam, brown (10YR 5/3) dry; moderate medium granular structure; hard, friable, slightly sticky and slightly plastic; many fine and very fine roots; medium acid (pH 5.8); clear smooth boundary. (6 to 9 inches thick)

AC-6 to 13 inches; dark brown (10YR 3/3) loam, brown (10YR 5/3) dry; moderate fine and medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; many fine and very fine roots; very few medium pores; medium acid (pH 5.8); clear smooth boundary. (4 to 8 inches thick)

C1-13 to 32 inches; dark yellowish brown (10YR 3/4) sandy loam, yellowish brown (10YR 5/4) dry; massive; soft, friable, slightly sticky and slightly plastic; common very fine roots; common fine and few medium pores; medium acid (pH 6.0); abrupt smooth boundary. (18 to 22 inches thick)

C2-32 to 36 inches; brown (10YR 4/3) sand, pale brown (10YR 6/3) dry; single grained; loose; few very fine roots; medium acid (pH 6.0); abrupt smooth boundary. (3 to 5 inches thick)

C3-36 to 54 inches; dark gray (10YR 4/1) fine sandy loam, light brownish gray (10YR 6/2) dry; common medium prominent yellowish red (5YR 4/6) mottles; massive; soft, friable, slightly sticky and slightly plastic; very few very fine roots; common fine pores; medium acid (pH 6.0); abrupt smooth boundary. (10 to 22 inches thick)

C4-54 to 60 inches; dark gray (10YR 4/1) very gravelly sand, gray (10YR 6/1) dry; single grained; loose, nonsticky; medium acid (pH 6.0).

The Ap and AC horizons have chroma of 2 or 3 moist or dry and are loam or sandy loam. The C horizon has chroma of 1 to 4 moist or dry. In some pedons the lower part of the C horizon is coarse sand. Reaction is medium acid to slightly acid.

Buckley series

The Buckley series consists of poorly drained soils that formed in the Osceola mudflow. Buckley soils are on plains and have slopes of 0 to 2 percent. The mean annual precipitation is about 50 inches, and the mean annual air temperature is about 50 degrees F.

Typical pedon of Buckley loam, 2,250 feet west of northwest corner of section 6, T. 19 N., R. 6 E.:

Ap-0 to 10 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) dry; weak very fine and fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; many roots; 15 percent gravel; medium acid (pH 5.6); clear smooth boundary. (10 to 14 inches thick)

B21-10 to 14 inches; brown (10YR 4/2) loam, pale brown (10YR 6/2) dry; common medium distinct yellowish red (5YR 4/8) mottles; weak fine subangular blocky structure; slightly hard, friable, nonsticky and slightly plastic; few very fine roots; few very fine pores; 15 percent gravel, many pebbles are rotten; few 0.5 to 20 millimeter iron concretions; medium acid (pH 5.8); clear smooth boundary. (3 to 5 inches thick)

B22-14 to 38 inches; brown (10YR 5/2) gravelly sandy loam, light gray (10YR 7/2) dry; many medium prominent strong brown (7.5YR 5/8) and yellowish red (5YR 4/8) mottles; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine and fine roots; common very fine pores; 20 percent gravel and scattered cobbles (many are rotten); medium acid (pH 6.0); abrupt smooth boundary. (20 to 25 inches thick)

B3t-38 to 60 inches; grayish brown (10YR 5/2) gravelly sandy clay loam, light gray (10YR 7/2) dry; common fine distinct strong brown (7.5YR 5/6) iron concretions; few medium faint grayish brown (2.5Y 5/2) mottles; massive; hard, firm, sticky and plastic; none to very few fine roots; common very fine pores; thin and moderately thick continuous clay films in pores, pale brown (10YR 7/3) dry; 20 percent gravel and scattered cobbles; slightly acid (pH 6.4).

The control section has 15 and 25 percent coarse fragments; it averages more than 15 percent fine and coarser sand and 18 to 22 percent clay. The A horizon is black (10YR 2/1) or very dark brown (10YR 2/2). It is strongly acid to slightly acid. The B2 horizon has hue of 10YR, value of 4 or 5 moist and 5 through 7 dry, and chroma of 2 moist and 2 or 3 dry. It has prominent mottles. It is gravelly sandy loam or gravelly loam and is medium acid to slightly acid. The B3 horizon has hue of 10YR or 2.5Y, value of 3 through 5 moist and 6 through 8 dry, and chroma of 2. It is gravelly sandy clay loam or gravelly sandy clay and is medium acid to slightly acid.

Chehalis series

The Chehalis series consists of well drained soils that formed in alluvium. Chehalis soils are on bottom lands and have slopes of 0 to 3 percent. The mean annual precipitation is about 45 inches, and the mean annual air temperature is about 50 degrees F.

Typical pedon of Chehalis silt loam on delta below Ohop Lake, 1,700 feet north and 100 feet east of southwest corner of section 11, T. 16 N., R. 4 E., elevation 500 feet:

Ap-0 to 7 inches; mixed dark brown (10YR 3/3) and reddish brown (5YR 3/4) silt loam, brown (10YR 5/3) dry; weak fine subangular blocky structure; hard, friable, sticky and plastic; many very fine and fine roots; many very fine pores; slightly acid (pH 6.4); abrupt smooth boundary. (6 to 8 inches thick)

A12-7 to 17 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; moderate medium to coarse subangular blocky structure; hard, friable, sticky and plastic; common very fine roots; common very fine pores; worm holes filled with organic matter; neutral (pH 6.6); clear smooth boundary. (8 to 10 inches thick)

B21-17 to 31 inches; mixed brown (10YR 3/3) and dark grayish brown (10YR 1/2) silt loam, pale brown (10YR 513) dry; moderate fine to medium subangular blocky structure; hard, friable, sticky and plastic; few very fine roots; many very fine pores; neutral (pH 6.6); clear smooth boundary. (10 to 15 inches thick)

B22-31 to 55 inches; mixed brown (10YR 4/3) and yellowish red (5YR 4/8) silt loam, pale brown (10YR 6/3) dry; moderate fine to medium subangular blocky structure; hard, friable, slightly sticky and plastic; few very fine roots; many very fine to fine pores; slightly acid (pH 6.4); clear smooth boundary. (20 to 30 inches thick)

C1-55 to 63 inches; dark grayish brown (10YR 4/2) silty clay, light brownish gray (10YR 6/2) dry; many medium distinct yellowish red (5YR 4/8) mottles; massive; very hard, firm, sticky and plastic; neutral (pH 6.9).

The mollic epipedon ranges in thickness from 20 to 33 inches. The Ap horizon has hue of 10YR, value of 3 moist and 5 dry, and chroma of 2 or 3 moist or dry. The B horizon has hue of 10YR, value of 3 or 4 moist and 5 or 6 dry, and chroma of 3 moist or dry. It is silt loam or silty clay loam. The C horizon has hue of 10YR or 2.5Y, value of 4 moist and 6 dry, and chroma of 2 or 3 moist or dry. It is silt loam, silty clay loam, silty clay, or, in some pedons, sand.

Cinebar series

The Cinebar series consists of well drained soils that formed in materials high in volcanic ash. Cinebar soils are on uplands and have slopes of 6 to 45 percent. The mean annual precipitation is 50 to 90 inches, and the mean annual air temperature is about 47 degrees F.

Typical pedon of Cinebar silt loam, 30 to 45 percent slopes, 1,500 feet west and 350 feet north of the southeast corner of section 1, T. 15 N., R. 4 E.:

O1-1 inch to 0; partially decomposed needles and twigs, clear smooth boundary.

A1-0 to 3 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; weak very fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; common fine to coarse roots; 10 percent 2 to 5 millimeter soft iron concretions; slightly acid (pH 6.2); clear smooth boundary. (3 to 5 inches thick)

B21-3 to 14 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; weak fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; common fine to coarse roots; 10 percent 2 to 5 millimeter soft iron concretions; slightly acid (pH 6.2); gradual smooth boundary. (6 to 15 inches thick)

B22-14 to 25 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; weak fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; common fine to coarse roots; few fine pores; common clear glass shards; medium acid (pH 5.8); clear smooth boundary. (15 to 30 inches thick)

B23-25 to 43 inches; dark yellowish brown (10YR 3/4) silt loam, brown (10YR 5/3) dry; weak medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; common fine to coarse roots; few very fine and fine pores; common clear and opaque glass shards or crystals less than 1 millimeter in size; medium acid (pH 5.8); clear smooth boundary. (15 to 20 inches thick)

B24-43 to 60 inches; dark yellowish brown (10YR 4/4) silt loam, light yellowish brown (10YR 6/4) dry; moderate medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; common fine to coarse roots; common very fine and fine pores; common clear glass shards or crystals less than 1 millimeter in size; medium acid (pH 5.8).

The profile is dominantly silt loam and contains 1 to 5 percent coarse angular andesite fragments. The umbric epipedon is 20 to 25 inches thick. The A1 horizon has hue of 10YR, value of 3 moist and 4 or 5 dry, and chroma of 2 or 3 moist or dry. The B2 horizon has hue of 10YR, value of 3 or 4 moist and 5 or 6 dry, and chroma of 3 or 4 moist or dry.

Dupont series

The Dupont series consists of very poorly drained soils that formed in decaying plant remains and diatomaceous earth. Dupont soils are in depressions or basins on uplands and have slopes of 0 to 2 percent. The mean annual precipitation is 35 to 70 inches, and the mean annual air temperature is about 48 degrees F.

Typical pedon of Dupont muck, 860 feet west and 1,320 feet south of northeast corner of section 35, T. 20 N., R. 2 E.:

Oa1-0 to 13 inches; black (5YR 2/1 rubbed) sapric material, black (10YR 2/1) dry; about 20 percent fibers, less than 5 percent rubbed; moderate fine subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; many roots; very strongly acid (pH 4.6); abrupt smooth boundary. (12 to 15 inches thick)

IIC1-13 to 16 inches; dark red (5YR 3/4) volcanic ash, strong brown (7.5YR 5/6) dry; moderate fine prismatic structure; slightly hard, very friable, nonsticky and nonplastic; common roots; very strongly acid (pH 5.0); abrupt smooth boundary. (2 to 5 inches thick)

Oa2-16 to 46 inches; black (5YR 2/1) sapric material, 30 percent fibers, 5 percent rubbed; moderate medium subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; common roots; very strongly acid (pH 4.8); clear wavy boundary. (28 to 36 inches thick)

Oa3-46 to 72 inches; black (5YR 2/1) sapric material; 40 percent fibers, about 5 to 10 percent rubbed; massive; slightly hard, very friable, nonsticky and nonplastic; very few roots; strongly acid (pH 5.4).

The organic material ranges in thickness from 52 inches to more than 10 feet. It is underlain by loose or compacted gravelly sand or gravelly sandy loam. The organic material is derived from spirea, sedges, and grasses. The sapric material has an unrubbed fiber content of 20 to 40 percent. Rubbed fiber content ranges from 10 percent to less than 5 percent. Near the perimeter of bogs, the surface and subsurface tiers have volcanic ash or diatomaceous layers 2 to 5 inches thick generally at a depth of 8 to 16 inches. In some pedons (center of the bogs) these layers are at a depth of 4 feet to more than 8 feet. The volcanic ash and diatomaceous materials have hue of 5YR, 7.5YR, or l0YR, value of 3 through 6, and chroma of 1 through 4. The tiers have hue of 5YR or l0YR.

Everett series

The Everett series consists of somewhat excessively drained soils that formed in glacial outwash. Everett soils are on terraces and terrace breaks and have slopes of 0 to 30 percent. The mean annual precipitation is 35 to 45 inches, and the mean annual air temperature is about 50 degrees F.

Typical pedon of Everett gravelly sandy loam, 0 to 6 percent slopes, 200 feet west and 200 feet south of northeast corner of section 28, T. 19 N., R. 4 E.:

A1-0 to 2 inches; very dark brown (10YR 2/2) gravelly sandy loam, dark grayish brown (10YR 4/2) dry; weak very fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; many roots; 40 percent gravel and 15 percent concretions; medium acid (pH 5.6); clear smooth boundary. (1 to 3 inches thick)

B21ir-2 to 8 inches; dark yellowish brown (10YR 3/4) gravelly sandy loam, yellowish brown (10YR 5/4) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; many roots; 40 percent gravel and 15 percent concretions; medium acid (pH 5.8); gradual wavy boundary. (5 to 7 inches thick)

B22ir-8 to 19 inches; dark brown (7.5YR 3/4) very gravelly coarse sandy loam, yellowish brown (10YR 5/4) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; many roots; 70 percent gravel and concretions; medium acid (pH 6.0); clear wavy boundary. (9 to 15 inches thick)

C-19 to 60 inches; olive brown (2.5Y 4/4) very gravelly sand, brown (10YR 5/3) dry; massive; loose; few roots; pale brown (10YR 6/3) manganese stains on underside of pebbles; 65 percent gravel; medium acid (pH 5.8).

The control section is 35 to 70 percent coarse fragments. The content of coarse fragments increases with depth. The A horizon has value of 2 moist and 4 dry and chroma of 1 or 2. Some pedons do not have an A horizon. The B horizon has hue of 10YR or 7.5YR, value of 3 or 4 moist and 4 through 6 dry, and chroma of 3 or 4. It is gravelly sandy loam or gravelly loam and is commonly very gravelly. The C horizon ranges from very gravelly coarse sand to very gravelly loamy sand.

Greenwater series

The Greenwater series consists of somewhat excessively drained soils that formed in sandy alluvium derived mainly from andesitic rocks and pumice. Greenwater soils are on terraces and have slopes of 0 to 3 percent. The mean annual precipitation is 50 to 70 inches, and the mean annual air temperature is about 49 degrees F.

Typical pedon of Greenwater loamy sand, 500 feet west and 3,000 feet north of southeast corner of section 2, T. 19 N., R. 6 E.:

Ap-0 to 9 inches; very dark brown (10YR 2/2) loamy sand, dark grayish brown (10YR 4/2) dry; weak very fine granular structure; soft, very friable, nonsticky and nonplastic; many very fine roots; about 7 percent fine pumice; medium acid (pH 5.8); clear smooth boundary. (6 to 10 inches thick)

B22ir-9 to 19 inches; dark yellowish brown (10YR 3/4) loamy sand, yellowish brown (10YR 5/4) dry; soft, friable, nonsticky and nonplastic; many very fine roots; about 10 percent fine pumice; medium acid (pH 5.8); clear smooth boundary. (9 to 12 inches thick)

C1-19 to 26 inches; very dark grayish brown (10YR 3/2) sand, gray (10YR 5/1) dry; compact (somewhat water-stable) coarse stratified layers; slightly hard, firm, nonsticky and nonplastic; few very fine roots; 8 percent fine pumice; medium acid (pH 6.0); gradual smooth boundary. (5 to 8 inches thick)

C2-26 to 61 inches; very dark gray (10YR 3/1) sand, gray (10YR 5/1) dry; single grained; few very fine roots; about 12 percent fine pumice; medium acid (pH 6.0)

The control section is 0 to 15 percent. The soil is 5 to 25 percent volcanic ash and pumice. The A horizon has value and chroma of 2 or 3 moist. The Bir horizon has value of 3 or 4 moist and 5 or 6 dry and chroma of 3 or 4 moist or dry. These horizons are loamy sand or sand. The C horizon has hue of 10YR or 2.5Y, value of 3 or 4, and chroma of 1 through 4. This horizon is stratified with thin layers of sandy loam and silt loam.

Harstine series

The Harstine series consists of moderately well drained soils that formed in sandy glacial till. Harstine soils are on uplands and have slopes of 0 to 45 percent. The mean annual precipitation is 40 to 50 inches, and the mean annual air temperature is about 50 degrees F.

Typical pedon of Harstine gravelly sandy loam, 0 to 6 percent slopes, 1,600 feet east and 4,000 feet north of southwest corner of section 36, T. 22 N., R. 1 E.:

O1-1 to 1/2 inch; twigs and needles; very strongly acid (pH 4.8); abrupt wavy boundary.

O2-1/2 inch to 0; decayed needles; very strongly acid (pH 4.8); abrupt wavy boundary.

B21-0 to 5 inches; dark yellowish brown (10YR 3/4) gravelly sandy loam, brown (10YR 5/3) dry; weak very fine subangular blocky structure; soft, very friable, nonsticky and slightly plastic; many roots; very strongly acid (pH 5.0); clear wavy boundary. (3 to 6 inches thick)

B22-5 to 13 inches; dark brown (7.5YR 3/4) gravelly sandy loam, yellowish brown (10YR 5/4) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; many roots; strongly acid (pH 5.4); clear wavy boundary. (7 to 9 inches thick)

B23-13 to 21 inches; brown (10YR 4/3) gravelly sandy loam, pale brown (10YR 6/3) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; many roots; strongly acid (pH 5.4); gradual wavy boundary. (7 to 9 inches thick)

B24-21 to 31 inches; dark yellowish brown (10YR 4/4) gravelly sandy loam, light yellowish brown (10YR 6/4) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; many roots; medium acid (pH 5.6); abrupt wavy boundary. (7 to 12 inches thick)

C1sim-31 to 37 inches; grayish brown (2.5Y 5/2) gravelly loamy sand, light brownish gray (10YR 6/2) dry; weakly cemented; massive; very hard, extremely firm; few roots in fractures; medium acid (pH 5.8); gradual wavy boundary. (5 to 7 inches thick)

C2sim-37 to 60 inches; grayish brown (2.5Y 5/2) gravelly loamy sand, light brownish gray (2.5Y 6/2) dry; compact, weakly cemented; glacial till.

These soils are usually moist, but they are dry in all parts between depths of 8 and 24 inches for 60 to 80 consecutive days in most years. Coarse fragments in the control section range from 15 to 25 percent. Depth to the Csim horizon ranges from 24 to 36 inches. Some pedons have a thin A1 horizon that has hue of 7.5YR or 10YR, value of 3 or 4, and chroma of 2 or 3 moist. The B horizon has hue of 10YR or 7.5YR, value of 3 or 4 moist and 5 or 6 dry, and chroma of 3 or 4 moist or dry. Some pedons have a thin loamy sand layer. The C horizon has hue of 10YR or 2.5YR, value of 4 through 6, and chroma of 2 through 4. It is coarse sandy loam or loamy sand and is gravelly. In some pedons the Csim horizon has mottles along fractures.

Indianola series

The Indianola series consists of somewhat excessively drained soils that formed in sandy glacial outwash. Indianola soils are on glacial eskers or kames and have slopes of 0 to 45 percent. The mean annual precipitation is about 35 inches, and the mean annual air temperature is about 50 degrees F.

Typical pedon of Indianola loamy sand, 6 to 15 percent slopes, 2,244 feet west and 1,584 feet south of northeast corner of section 27, T. 19 N., R. 4 E.:

O1-3/4 to 1/2 inch; undecomposed needles, twigs, leaves, bark; medium acid (ph 5.8).

O2-1/2 inch to 0; decomposed organic material and soil; sandy loam; medium acid (pH 5.8); abrupt smooth boundary.

B2ir-0 to 7 inches; dark brown (10YR 3/3) loamy sand, brown (10YR 5/3) dry; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; common roots; medium acid (pH 6.0); clear wavy boundary. (5 to 10 inches thick)

B22ir-7 to 20 inches; dark yellowish brown (10YR 3/4) sand, light yellowish brown (10YR 6/4) dry; massive; loose; common roots; slightly acid (pH 6.2); gradual wavy boundary. (6 to 13 inches thick)

C1-20 to 31 inches; brown (10YR 4/3) sand, pale brown (10YR 6/3) dry; massive; loose; few roots; slightly acid (pH 62); gradual wavy boundary. (10 to 15 inches thick)

C2-31 to 57 inches; dark yellowish brown (10YR 4/4) sand, pale brown (10YR 6/3) dry; loose; very few roots; slightly acid (pH 62); gradual wavy boundary. (15 to 30 inches thick)

C3-57 to 78 inches; olive brown (2.5Y 4/4) sand, light olive brown (2.5Y 5/4) dry; loose; very few roots; few fine and very fine dark yellowish brown (10YR 4/4) bands; medium acid (pH 6.0).

The control section is less than 15 percent coarse fragments. Some pedons have a thin dark A1 horizon or a thin B3 horizon, or both. The Bir horizon has hue of 10YR or 7.5YR, value of 3 or 5 moist and 5 or 6 dry, and chroma of 3 or 4. It is loamy sand or sand. The C horizon ranges from 10YR through 5Y in hue, from 4 through 6 in value, and from 2 through 4 in chroma. It is loamy fine sand or sand.

Kapowsin series

The Kapowsin series consists of moderately well drained soils that formed in glacial till. Kapowsin soils are on uplands and have slopes of 0 to 70 percent. The mean annual precipitation is 35 to 45 inches, and the mean annual air temperature is about 50 degrees F.

Typical pedon of Kapowsin gravelly loam, 6 to 15 percent slopes, along B.P.A. powerline right-of-way, 660 feet west and 1,603 feet south of northeast corner of section 28, T. 18 N., R. 4 E.:

Apcn-0 to 7 inches; dark brown (10YR 3/3) gravelly loam, brown (10YR 5/3) dry; weak very fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; many roots; few very fine pores; many hard black 2 to 5 millimeter concretions; 20 percent gravel; few cobbles, medium acid (pH 5.6); clear smooth boundary. (2 to 7 inches thick)

B21cn-7 to 11 inches; dark brown (10YR 3/3) gravelly loam, light brownish gray (10YR 6/2) dry; common fine faint dark yellowish brown (10YR 4/4) mottles; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common roots; few very fine pores; many hard black 2 to 5 millimeter concretions; 20 percent gravel, strongly acid (pH 5.5); clear wavy boundary. (4 to 5 inches thick)

B22cn-11 to 16 inches; dark yellowish brown (10YR 4/4) gravelly loam, pale brown (10YR 6/3) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common roots; few very fine pores; few hard black 2 to 5 millimeter concretions; 20 percent gravel; medium acid (pH 5.8); clear wavy boundary. (5 to 11 inches thick)

B23cn-16 to 25 inches; brown (10YR 5/3) loam, very pale brown (10YR 7/3) dry; few fine faint mottles; moderate medium subangular blocky structure; slightly hard, friable, sticky and slightly plastic; common roots; few very fine pores; few hard black 2 to 5 millimeter concretions; 10 percent gravel; medium acid (pH 5.2) ; clear wavy boundary. (5 to 9 inches thick)

C1sim-25 to 29 inches; olive brown (2.5Y 4/4 rubbed) loam, light gray (2.5Y 7/2) dry; many medium distinct dark yellowish brown (10YR 4/4) and light brownish gray (2.5Y 6/2) mottles along horizontal planes; massive; weakly cemented, very hard, very firm; breaks into very rough plates; few very fine pores; moderately thick clay films in some pores and in places on plates; 10 percent gravel; medium acid (pH 5.8); abrupt irregular boundary. (10 to 20 inches thick)

C2-29 to 59 inches; grayish brown (2.5Y 5/2) gravelly loam, light brownish gray (2.5Y 6/2) dry; massive; strongly compacted, hard, firm, slightly sticky and slightly plastic; very few very fine roots; few very fine pores; thin discontinuous dark brown (7.5YR 4/4) clay films on horizontal sides of fractured pieces; 20 percent gravel; medium acid (pH 5.8); gradual wavy boundary. (10 to 21 inches thick)

C3-59 to 91 inches; grayish brown (2.5Y 5/2) gravelly loam, light gray (2.5Y 7/2) dry; massive; very compacted, hard, firm, sticky and slightly plastic; medium acid (pH 5.8).

Few stones and cobbles occur throughout the solum. Soil reaction is strongly to slightly acid. The A horizon has hue of 10YR or 7.5YR, value of 3 or 4 moist, and chroma of 2 or 3 moist. The B2cn horizon has hue of 7.5YR or 10YR, value of 3 through 5 moist, and chroma of 3 or 4 moist. Its texture is loam or sandy loam, and it is gravelly in places. Depth to the Csim horizon ranges from 18 to 32 inches. The Clsim horizon has value of 4 or 5 moist and chroma of 2 to 4 moist. Its texture is loam or heavy loam, and it is gravelly in places. The horizon generally is mottled, but it does not have mottles with chroma of 2 or less within 20 inches of the surface. The C2 and C3 horizons have value of 4 or 5 moist. They are sandy loam, loam, or heavy loam and are gravelly. In places they contain strata of clay, fine silt, or sand 3 to 10 inches in thickness.

Kitsap series

The Kitsap series consists of moderately well drained soils that formed in glacial lake sediments. Kitsap soils are on remnant upland benches and have slopes of 0 to 65 percent. The mean annual precipitation is 35 to 50 inches, and the mean annual air temperature is about 50 degrees F.

Typical pedon of Kitsap silt loam, 2 to 8 percent slopes, 100 feet north of corner of 104th Street and 80th Avenue; 2,050 feet west and 2,750 feet south of the northeast corner of section 5, T. 19 N., R. 4 E.:

Ap-0 to 6 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; medium acid (pH 5.8); abrupt smooth boundary. (3 to 6 inches thick)

B21-6 to 10 inches; dark brown (10YR 4/3) silt loam, pale brown (10YR 6/3) dry; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; few very fine pores; many 2 to 5 millimeter light brown (7.5YR 6/4) concretions; medium acid (pH 6.0); clear wavy boundary. (3 to 12 inches thick)

B22-10 to 17 inches; brown (10YR 4/3) silty clay loam, pale brown (10YR 6/3) dry; moderate medium subangular blocky structure; hard, firm, sticky and plastic; many very fine and fine roots; common very fine and fine pores; about 3 percent fine gravel; few 2 to 5 millimeter light brown (7.5YR 6/4) concretions; few silt balls; few krotovinas; slightly acid (pH 6.4); clear wavy boundary. (4 to 10 inches thick)

B3-17 to 32 inches; grayish brown (2.5Y 5/2) silty clay loam, light brown (2.5YR 7/2) dry; many large prominent strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure; hard, firm, sticky and plastic; few very fine roots; common very fine and fine pores; slightly acid (pH 6.5); clear irregular boundary. (14 to 35 inches thick)

C-32 to 60 inches; light olive brown (2.5Y 5/4) silt loam and silty clay loam, light brownish gray (2.5Y 6/2) dry; very fine and fine stratification; hard, firm, sticky and plastic; few very fine roots; few very fine and fine pores; tongues of grayish brown (2.5Y 5/2) material like the B3 horizon; neutral (pH 6.6).

The control section is less than 5 percent coarse fragments by volume. Depth to prominent mottles is 17 to 24 inches. The A horizon has value of 2 or 3 moist and 4 or 5 dry and chroma of 2 or 3 moist or dry. It is silt loam or loam. The B2 horizon has value of 3 or 4 moist and 5 or 6 dry and chroma of 3 or 4 moist or dry. It is silt loam or silty clay loam and has weak to moderate blocky structure. The B3 horizon has a hue of 10YR or 2.5Y, value of 4 through 6 moist and 6 through 8 dry, and chroma of 2 through 4 moist or dry. It is prominently mottled. It has blocky or prismatic structure or is massive. The C horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 2 through 4. It is mottled. In some pedons bluish gray (5B 5/1) gleying is prominent in root channels. It is silt loam or silty clay loam. Some pedons contain thin strata of silty clay, silt, or fine sand.

McKenna series

The McKenna series consists of poorly drained soils that formed in glacial till. McKenna soils are in upland depressions and drainageways. Slopes are 0 to 3 percent. The mean annual precipitation is 35 to 50 inches, and the mean annual air temperature is about 50 degrees F.

Typical pedon of McKenna gravelly loam, 150 feet east of northwest corner of section 18, T. 16 N., R. 3 E.:

A1-0 to 11 inches; very dark brown (10YR 2/2) gravelly loam, grayish brown (10YR 5/2) dry; moderate very fine subangular blocky structure; hard, friable, sticky and plastic; common very fine and fine roots; few very fine and fine pores; 15 to 20 percent gravel; medium acid (pH 6.0); clear smooth boundary. (10 to 12 inches thick)

B2g-11 to 18 inches; dark grayish brown (10YR 4/2) gravelly loam, light brownish gray (10YR 6/2) dry; medium fine subangular blocky structure; slightly hard, firm, slightly sticky and plastic; few very fine to medium pores; 15 to 20 percent gravel; medium acid (pH 6.0); clear wavy boundary. (7 to 14 inches thick)

C1g-18 to 31 inches; grayish brown (10YR 5/2) gravelly clay loam, light gray (10YR 7/2) dry; massive; hard, firm, sticky and very plastic; few very fine and fine pores; medium acid (pH 5.8); clear wavy boundary. (10 to 14 inches thick)

C2-31 to 60 inches; grayish brown (10YR 5/2) gravelly silty clay, light brownish gray (10YR 6/2) dry; common fine distinct strong brown (7.5YR 5/8) mottles; massive; weakly cemented, very hard, very firm, very sticky and very plastic; thin discontinuous clay films; few fine to medium manganese stains; medium acid (pH 5.8).

The depth to the C1 horizon is 18 to 30 inches. Coarse fragments make up 15 to 25 percent of the A and B horizons. Reaction is slightly acid to medium acid throughout. The A horizon has value of 2 or 3 moist and 4 or 5 dry. The B2 horizon has a value of 3 through 5 moist and 5 through 7 dry. It is gravelly loam or gravelly silt loam. The C horizon has hue of 10YR or 2.5Y, value of 5 or 6 moist, and chroma of 1 or 2. Mottles range from common to prominent. Its texture is sandy loam, loam, clay loam, or silty clay, and it is gravelly or very gravelly.

National series

The National series consists of well drained soils that formed in volcanic ash and pumice and the underlying alluvium. National soils are on terraces and have slopes of 0 to 3 percent. The mean annual precipitation is about 80 inches, and the mean annual air temperature is about 45 degrees F.

Typical pedon of National gravelly sandy loam, 1,640 feet south and 650 feet west of the northeast corner of section 29, T. 15 N., R. 4 E.:

O2-2 inches to 0; black (5Y 2/1) duff; soft, very friable, nonsticky and slightly plastic; many very fine to coarse roots; very strongly acid (pH 4.6); abrupt smooth boundary. (1 to 3 inches thick)

A1-0 to 10 inches; very dark grayish brown (10YR 3/2) gravelly sandy loam, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and slightly plastic; many very fine to coarse roots; 40 percent pumice gravel 2 to 5 millimeters in size; medium acid (pH 5.6); clear smooth boundary. (7 to 12 inches thick)

B1-10 to 16 inches; dark brown (10YR 3/3) gravelly loamy coarse sand, pale brown (10YR 6/3) dry; weak medium subangular blocky structure parting to single grained; soft, very friable, nonsticky and nonplastic; common very fine, fine, and coarse roots; many very fine and fine pores; 40 percent pumice gravel 2 to 5 millimeters in size; medium acid (pH 6.0); clear wavy boundary. (5 to 7 inches thick)

B21-16 to 26 inches; brown (10YR 4/3) gravelly sandy loam, pale brown (10YR 6/3) dry; weak medium subangular blocky structure; soft, friable, slightly sticky and slightly plastic; common very fine, fine, and coarse roots; many very fine and fine pores; 40 percent pumice gravel 2 to 5 millimeters in size; medium acid (pH 5.8); clear smooth boundary. (9 to 12 inches thick)

IIB22-26 to 41 inches; brown (10YR 4/3) loam, light yellowish brown (10YR 6/4) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; common very fine and fine pores; medium acid (pH 5.9); abrupt smooth boundary. (14 to 17 inches thick)

IIC1-41 to 49 inches; dark yellowish brown (10YR 4/4) sandy loam, pale brown (10YR 6/3) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; common fine and very fine pores; 10 percent gravel; medium acid (pH 5.9); clear wavy boundary. (7 to 9 inches thick)

IIC2-49 to 61 inches; yellowish brown (10YR 5/4) silt loam, pale brown (10YR 6/3) dry; common fine faint yellowish brown (10YR 5/6 dry) mottles; massive; hard, friable, slightly sticky and slightly plastic; common very fine and fine pores; medium acid (pH 6.0).

Coarse fragments, dominantly pumice, in the upper part make up 35 to 45 percent. The A horizon has hue of 10YR or 7.5YR, value of 2 or 3 moist and 4 or 5 dry, and chroma of 2 or 3 moist or dry. The B horizon has hue of 10YR or 7.5YR, value of 3 or 4 moist and 5 or 6 dry, and chroma of 3 or 4 moist or dry. It is sandy loam or loamy sand and is gravelly. The IIB2 horizon has a hue of 10YR or 7.5YR, value of 4 or 5 moist and 6 or 7 dry, and chroma of 3 or 4 moist or dry. It is sandy loam, fine sandy loam, or loam. The IIC horizon ranges from sandy loam, fine sandy loam, or loam to silt loam, and in some pedons, it contains pebbles, cobbles, and stones.

Neilton series

The Neilton series consists of excessively drained soils that formed in gravelly glacial outwash. Neilton soils are on eskers and have slopes of 8 to 25 percent. The mean annual precipitation is 35 to 55 inches, and the mean annual air temperature is about 50 degrees F.

Typical pedon of Neilton gravelly loamy sand, 8 to 25 percent slopes, 1,300 feet west and 2,800 feet south of the northeast corner of section 16, T. 22 N., R. 1 E.:

O1-1/2 inch to 0; undecomposed needles, twigs, and moss.

A1-0 to 3 inches; black (10YR 2/1) gravelly loamy sand, very dark grayish brown (10YR 3/2) dry; weak very fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine roots; strongly acid (pH 5.4); clear smooth boundary. (0 to 3 inches thick)

B2-3 to 21 inches; brown (10YR 4/3) gravelly loamy sand, yellowish brown (10YR 5/4) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine, fine, and medium roots; 15 to 20 percent gravel, 5 percent cobbles; strongly acid (pH 5.4); clear wavy boundary. (10 to 19 inches thick)

C-21 to 60 inches; multicolored clean very gravelly sand; single grained; loose; few fine and many very fine roots; 70 percent gravel; medium acid (pH 5.8); gradual smooth boundary.

The control section is 20 to 70 percent coarse fragments. The Al horizon has value of 2 moist and 3 dry and chroma of 1 or 2. The B2 horizon has value of 4 moist and 4 or 5 dry and chroma of 3 or 4. It is gravelly or very gravelly loamy sand or sand. The C horizon is dominantly very gravelly sand. In many pedons it contains layers of sand and gravelly sand.

Nisqually series

The Nisqually series consists of somewhat excessively drained soils that formed in sandy glacial outwash. Nisqually soils are on upland plains and have slopes of 2 to 6 percent. The mean annual precipitation is 35 to 45 inches, and the mean annual air temperature is about 51 degrees F.

Typical pedon of Nisqually loamy sand, 2,452 feet south of the northwest corner of section 3, T. 17 N., R. 2 E.:

A11-0 to 7 inches; black (10YR 2/1) loamy sand, very dark grayish brown (10YR 3/2) dry; weak very fine granular structure; soft, very friable, nonsticky and nonplastic; many roots; 1 to 2 percent fine gravel; slightly acid (pH 6.4); gradual smooth boundary. (6 to 8 inches thick)

A12-7 to 19 inches; black (10YR 2/1) loamy sand, very dark grayish brown (10YR 3/2) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; many roots; few very fine pores; 1 to 2 percent fine gravel; slightly acid (pH 6.2); gradual wavy boundary. (10 to 12 inches thick)

A13-19 to 25 inches; very dark brown (10YR 2/2) loamy sand, dark grayish brown (10YR 4/2) dry; weak very fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; many roots; 1 to 2 percent fine gravel; slightly acid (pH 6.4); gradual irregular boundary. (5 to 7 inches thick)

C1-25 to 60 inches; dark grayish brown (2.5Y 4/2) sand, light brownish gray (2.5Y 6/2) dry; single grained; loose; common to few roots; 1 to 2 percent fine gravel; slightly acid (pH 6.5).

Reaction is slightly acid to medium acid throughout. The A horizon has value of 2 or 3 moist and 3 or 4 dry and chroma of 1 or 2 moist or dry. The C horizon has hue of 10YR through 5Y, dominantly value of 4 or 5 moist and 5 or 6 dry, and chroma of 2 moist or dry.

Norma series

The Norma series consists of poorly drained soils that formed in alluvium. Norma soils are along upland drainage channels and have slopes of 0 to 3 percent. The mean annual precipitation is 35 to 60 inches, and the mean annual air temperature is about 50 degrees F.

Typical pedon of Norma fine sandy loam, 2,772 feet south and 87 feet east of the northwest corner of section 29, T. 18 N., R. 4 E.:

Ap-0 to 9 inches; very dark brown (10YR 2/2) fine sandy loam, dark grayish brown (10YR 4/2) dry; weak fine and medium granular structure; soft, very friable, nonsticky and slightly plastic; many roots; medium acid (pH 6.0); clear wavy boundary. (5 to 10 inches thick)

B21g-9 to 30 inches; dark grayish brown (10YR 4/2) fine sandy loam, light brownish gray (10YR 6/2) dry; many medium and coarse distinct dark reddish brown (5YR 3/2) and dark yellowish brown (10YR 3/4) mottles; moderate medium and coarse angular blocky structure; hard, firm, nonsticky and slightly plastic; common roots; many very fine and few fine pores; slightly acid (pH 62); clear wavy boundary. (15 to 22 inches thick)

C1g-30 to 47 inches; grayish brown (2.5Y 5/2) sandy loam, light gray (2.5Y 7/2) dry; common medium prominent dark brown (7.5YR 3/2) mottles; massive; slightly hard, friable, nonsticky and nonplastic; few roots; common very fine and few fine pores; slightly acid (pH 6.2); clear wavy boundary. (10 to 18 inches thick)

C2g-47 to 71 inches; grayish brown (2.5Y 5/2) sandy loam, light gray (2.5Y 7/2) dry; common medium and coarse faint *gray* (5Y 5/1) mottles, dry; massive; slightly hard, friable, nonsticky and nonplastic; very few roots; slightly acid (pH 6.4).

The A horizon has value of 2 or 3 moist and 3 or 4 dry. The Bg horizon has hue of 10YR through 5YR and value of 4 or 5 moist and 6 or 7 dry, and it has common to many distinct and prominent mottles. It has weak to moderate blocky structure. The texture is fine sandy loam or sandy loam. The C horizon is commonly fine sandy loam, sandy loam, or loamy coarse sand. Some pedons contain thin strata of silt, silt loam, and fine sandy loam or gravelly sand in the lower part of the C horizon.

Orting series

The Orting series consists of somewhat poorly drained soils that formed in the Electron mudflow. Orting soils are on a plain and have slopes of 0 to 3 percent. The mean annual precipitation is 35 to 50 inches, and the mean annual air temperature is about 50 degrees F.

Typical pedon of Orting loam, 1,200 feet west and 1,200 feet north of the southeast corner of section 24, T. 19 N., R. 4 E.:

Ap1-0 to 7 inches; very dark grayish brown (10YR 3/2) loam, brown (10YR 5/3) dry; moderate medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; 5 percent gravel; medium acid (pH 5.6); abrupt smooth boundary. (6 to 8 inches thick)

Ap2-7 to 12 inches; very dark grayish brown (10YR 3/2) loam, brown (10YR 5/3) dry; moderate coarse subangular blocky structure; hard, friable, slightly sticky and slightly plastic; 5 percent gravel; medium acid (pH 5.6); abrupt smooth boundary. (4 to 6 inches thick)

B2-12 to 24 inches; dark yellowish brown (10YR 3/4) gravelly coarse sandy clay loam, pale brown (10YR 6/3) dry; common fine distinct strong brown (7.5YR 5/6) mottles; massive; hard, friable, slightly sticky and plastic; common very fine pores; strong organic staining in former root channels; 20 percent gravel; slightly acid (pH 6.2); gradual wavy boundary. (10 to 14 inches thick)

C1g-24 to 61 inches; brown (10YR 4/3) gravelly coarse sandy clay loam, light brownish gray (10YR 6/2) dry; common medium distinct yellowish red (5YR 4/6) mottles; massive; hard, firm, sticky and plastic; common very fine and few fine and medium pores; thick deposits of clay or silt, or both, in fine and medium pores; 20 percent gravel; slightly acid (pH 6.4); gradual wavy boundary. (34 to 40 inches thick)

C2g-61 to 69 inches; dark gray (N 4/) gravelly coarse sandy clay loam, gray (10YR 6/1) dry; massive; hard, firm, sticky and plastic; 20 percent gravel; slightly acid (pH 6.4).

The control section is 15 to 25 percent coarse fragments, 25 to 34 percent clay, and more than 15 percent sand coarser than very fine sand. The A horizon has moist value and chroma of 2 or 3 and loam or sandy loam texture. The B horizon has moist value and chroma of 3 or 4. It has distinct or prominent yellowish brown, strong brown, or yellowish red mottles. The C horizon has mottles that are distinct or prominent and are yellowish red or strong brown. Boulders, stones, and cobbles are common in the C horizon.

Pilchuck series

The Pilchuck series consists of excessively drained soils that formed in alluvium. Pilchuck soils are on flood plains and have slopes of 0 to 3 percent. The mean annual precipitation is 35 to 60 inches, and the mean annual air temperature is about 50 degrees F.

Typical pedon of Pilchuck fine sand, 758 feet east and 190 feet north of southwest corner of section 18, T. 19 N., R. 5 E.:

Ap-0 to 7 inches; very dark brown (10YR 2/2) fine sand, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and slightly plastic; many roots; medium acid (pH 6.0); clear smooth boundary. (6 to 8 inches thick)

C1-7 to 19 inches; very dark brown (10YR 2/2) fine sand, grayish brown (10YR 5/2) dry; massive; loose, nonsticky and nonplastic; few roots; neutral (pH 6.6); gradual wavy boundary. (10 to 18 inches thick)

C2-19 to 36 inches; very dark brown (10YR 2/2) fine sand, grayish brown (10YR 5/2) dry; single grained; loose, nonsticky and nonplastic; few roots; neutral (pH 6.8); abrupt wavy boundary. (10 to 18 inches thick)

C3-36 to 60 inches; very dark brown (10YR 2/2) very gravelly sand, grayish brown (10YR 5/2) dry; single grained; loose, nonsticky and nonplastic; slightly acid (pH 6.4).

Coarse fragments range to more than 60 percent by volume in the lower part of the C horizon. The A horizon has weak granular or blocky structure. The C horizon is massive or single grained. In many pedons the color is that of the original parent material. The upper part of the profile is loamy sand, loamy fine sand, or fine sand, and the lower part is gravelly sand or very gravelly sand.

Puget series

The Puget series consists of poorly drained soils that formed in alluvium. Puget soils are on flats or depressions in river valleys and have slopes of 0 to 2 percent. The mean annual precipitation is 35 to 50 inches, and the mean annual air temperature is about 50 degrees F.

Typical pedon of Puget silty clay loam, 2,300 feet east and 1,000 feet north of the southwest corner of section 13, T. 20 N., R. 4 E.:

Ap-0 to 11 inches; dark grayish brown (10YR 4/2) silty clay loam, light brownish gray (10YR 6/2) dry; strong coarse angular blocky structure; hard, firm, sticky and plastic; many fine roots; common very fine pores; strongly acid (pH 5.4); very abrupt smooth boundary. (8 to 12 inches thick)

C1g-11 to 14 inches; grayish brown (10YR 5/2) silty clay loam, light gray (10YR 7/2) dry; common fine prominent dark reddish brown (5YR 3/4) and yellowish red (5YR 5/8) mottles; moderate coarse platy structure; hard, firm, very sticky and very plastic; many fine roots; common very fine pores; medium acid (pH 5.6); abrupt smooth boundary. (2 to 7 inches thick)

C2g-14 to 24 inches; dark grayish brown (10YR 4/2) silty clay loam; light brownish gray (10YR 6/2) dry; common medium prominent yellowish red (5YR 5/6) mottles; strong medium subangular blocky structure; hard, firm, very sticky and very plastic; common fine roots; common fine and very fine pores; strongly acid (pH 5.4); clear smooth boundary. (9 to 12 inches thick)

C3g-24 to 52 inches; dark grayish brown (10YR 4/2) silty clay loam, light brownish gray (10YR 6/2) dry; common medium prominent dark reddish brown (5YR 3/3) mottles; finely stratified; hard, firm, sticky and plastic; few very fine roots; common medium fine and very fine pores; medium acid (pH 5.6); clear smooth boundary. (26 to 30 inches thick)

C4g-52 to 60 inches; dark gray (10YR 4/1) silt loam, light brownish gray (2.5Y 6/2) dry; many coarse prominent yellowish red (5YR 4/8) mottles; finely stratified; hard, firm, sticky and plastic; few very fine roots; many very fine pores; medium acid (pH 6.0).

The Ap horizon has hue of 10YR or 2.5Y and value of 6 or 7 dry. The Cg horizon has hue of 10YR or 2.5Y, value of 4 or 5 moist and 6 or 7 dry, and chroma of 1 or 2 moist and dry. It has yellowish red (5YR 4/6, 4/8, 5/8) and strong brown (7.5YR 5/6, 5/8) mottles, is silty clay loam, and has moderate to strong platy or blocky structure or fine stratification. Some pedons contain thin lenses of sand or loamy sand up to 2 inches thick in the Cg horizon.

Puyallup series

The Puyallup series consists of well drained soils that formed in alluvium. Puyallup soils are on low stream terraces of major river valleys and have slopes of 0 to 3 percent. The mean annual precipitation is 35 to 50 inches, and the mean annual air temperature is about 50 degrees F.

Typical pedon of Puyallup fine sandy loam, 950 feet west and 2,260 feet south of the northeast corner of section 6, T. 19 N., R. 5 E.:

Ap-0 to 6 inches; very dark brown (10YR 2/2) fine sandy loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; many fine roots; neutral (pH 6.6); clear smooth boundary. (6 to 8 inches thick)

A12-6 to 13 inches; very dark brown (10YR 2/2) fine sandy loam, dark grayish brown (10YR 4/2) dry; weak medium subangular blocky structure; slightly hard, friable, nonsticky and slightly plastic; many very fine roots; slightly acid (pH 6.4); abrupt smooth boundary. (6 to 8 inches thick)

C1-13 to 29 inches; very dark grayish brown (10YR 3/2) loamy fine sand, grayish brown (10YR 5/2) dry; few fine faint mottles; massive; slightly hard, friable, nonsticky and slightly plastic; common very fine roots; slightly acid (pH 6.2); abrupt smooth boundary. (14 to 18 inches thick)

C2-29 to 50 inches; very dark grayish brown (10YR 3/2) fine sand, grayish brown (10YR 5/2) dry; few fine mottles; massive; soft, very friable, nonsticky and nonplastic; few very fine roots; neutral (pH 6.6); abrupt smooth boundary. (18 to 22 inches thick)

C3-50 to 56 inches; dark grayish brown (10YR 4/2) fine sandy loam, light brownish gray (10YR 6/2) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; slightly acid (pH 6.4); abrupt smooth boundary. (5 to 7 inches thick)

C4-56 to 68 inches; dark grayish brown (10YR 4/2) fine sand, light brownish gray (10YR 6/2) dry; single grained; loose; slightly acid (pH 6.4).

The A horizon has value of 2 or 3 moist. It has weak granular or blocky structure. The C horizon has value of 3 or 4 moist and 5 or 6 dry and chroma of 2 or 3 moist and dry. In some pedons the lower part of the C horizon has distinct mottles and layers of silt loam, fine sandy loam, and gravelly sand 1 to 3 inches in thickness.

Ragnar series

The Ragnar series consists of well drained soils that formed in alluvium. Ragnar soils are on upland kame terraces and have slopes of 0 to 15 percent. The mean annual precipitation is 35 to 55 inches, and the mean annual air temperature is about 50 degrees F.

Typical pedon of Ragnar sandy loam, 0 to 6 percent slopes, 2,180 feet east and 160 feet west of southwest corner of section 20, T. 19 N., R. 4 E.:

Ap-0 to 7 inches; dark yellowish brown (10YR 3/4) sandy loam, brown (1OYR 5/3) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; many very fine roots; medium acid (pH 6.0); abrupt smooth boundary. (6 to 10 inches thick)

B21-7 to 15 inches; brown (10YR 4/3) sandy loam, pale brown (10YR 6/3) dry; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; many very fine roots and few fine pores; few (2 to 5 millimeter) iron concretions; slightly acid (pH 6.2); clear wavy boundary. (7 to 10 inches thick)

B22-15 to 26 inches; brown (10YR 4/3) sandy loam, pale brown (10YR 6/3) dry; weak coarse subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine roots; few very fine pores; few (2 to 5 millimeter) iron concretions; slightly acid (pH 6.4); gradual wavy boundary. (10 to 12 inches thick)

C1-26 to 37 inches; dark grayish brown (2.5Y 4/2) fine sand, light brownish gray (2.5Y 6/2) dry; massive; soft, very friable, nonsticky and nonplastic; few very fine roots; slightly acid (pH 6.4); gradual wavy boundary. (10 to 12 inches thick)

C2-37 to 50 inches; dark grayish brown (2.5Y 4/2) loamy sand, light brownish gray (2.5Y 6/2) dry; massive; soft, very friable, nonsticky and nonplastic; few very fine roots; slightly acid (pH 6.4); gradual wavy boundary. (12 to 14 inches thick)

C3-50 to 68 inches; dark grayish brown (2.5Y 4/2) sand, grayish brown (2.5Y 5/2) dry; single grained; loose when dry and moist; few very fine roots; slightly acid (pH 6.4).

The A horizon has chroma of 2 to 4 moist and dry. The B horizon has value of 3 to 5 moist and chroma of 3 or 4 moist and dry. The C horizon has value of 3 or 4 moist and chroma of 2 to 4 moist and dry.

Reed series

The Reed series consists of poorly drained soils that formed in alluvium. Reed soils are in low, flat depressions on flood plains and have slopes of 0 to 2 percent. The mean annual precipitation is 45 to 55 inches, and the mean annual air temperature is about 50 degrees F.

Typical pedon of Reed silty clay, 2,300 feet north and 400 feet east of the southeast corner of section 16, T. 16 N., R. 4 E.:

Ap-0 to 6 inches; dark grayish brown (10YR 4/2) silty clay, light brownish gray (10YR 6/2) dry; few fine faint yellowish red (5YR 4/6) mottles in root channels; strong medium subangular blocky structure; very hard, firm, sticky and plastic; many very fine roots; many very fine pores; medium acid (pH 5.6); abrupt smooth boundary. (6 to 7 inches thick)

C1g-6 to 21 inches; dark grayish brown (10YR 4/2) silty clay, light brownish gray (2.5YR 6/2) dry; common medium distinct yellowish red (5YR 4/6) mottles along root channels, common dark reddish brown (5YR 3/2) stains; moderate medium prismatic structure parting to moderate medium subangular blocky; very hard, firm, sticky and very plastic; common very fine roots; many very fine pores; slightly acid (pH 6.2); gradual smooth boundary. (14 to 19 inches thick)

C2g-21 to 38 inches; dark gray (10YR 4/1) silty clay loam, gray (10YR 6/1) dry; common medium prominent yellowish red (5YR 4/8) mottles; strong medium subangular blocky structure; hard, firm, sticky and plastic; few very fine roots; many very fine and fine pores; many medium black (5YR 2/1) manganese stains; slightly acid (pH 6.4); clear smooth boundary. (14 to 19 inches thick)

C3g-38 to 45 inches; grayish brown (10YR 5/2) silty clay loam, light brownish gray (2.5Y 6/2) dry; common medium prominent yellowish red (5YR 4/8) mottles; massive; hard, firm, sticky and plastic; few fine roots; many very fine and fine pores; many medium olive brown (2.5Y 3/4) manganese stains; medium acid (pH 5.8); abrupt smooth boundary. (5 to 10 inches thick)

C4g-45 to 55 inches; gray brown (2.5Y 5/2) silt loam, light brown gray (2.5Y 6/2) dry; common medium prominent yellowish red (5YR 4/8) mottles; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine and fine pores; medium acid (pH 5.6); abrupt smooth boundary. (5 to 10 inches thick)

C5g-55 to 62 inches; dark greenish gray (5BG 4/1) silt loam, olive (5Y 5/3) dry; massive; slightly hard, friable; neutral (pH 6.9).

The Ap horizon has hue of 10YR or 2.5Y and value of 4 or 5 moist and 4 through 6 dry. It has moderate to strong medium prismatic or subangular blocky structure. The Cg horizon has hue of 10YR through 5Y, value of 3 through 6 moist and 5 through 8 dry, and chroma of 1 through 3. The Cg horizon ranges from silty clay to silt loam and has moderate or strong prismatic or blocky structure in the upper part and is massive in the lower part

Scamman series

The Scamman series consists of somewhat poorly drained soils that formed in clayey glacial till. Scamman soils are on uplands and have slopes of 6 to 70 percent. The mean annual precipitation is 50 to 80 inches, and the mean annual air temperature is about 50 degrees F.

Typical pedon of Scamman silt loam, 6 to 15 percent slopes, 1,800 feet west and 1,560 feet north of southwest corner of section 3, T. 15 N., R. 4 E.:

O1-4 inches to 1 inch; needles, twigs, wood fragments.

O2-1 inch to 0; black (10YR 2/1) partially decomposed needles and twigs; abrupt smooth boundary.

A1-0 to 7 inches; very dark grayish brown (10YR 3/2) silt loam, light brownish gray (10YR 6/2) dry; moderate medium subangular blocky structure; slightly hard, friable, sticky and plastic; many roots; medium acid (pH 5.8); clear smooth boundary. (5 to 8 inches thick)

A2-7 to 14 inches; dark grayish brown (10YR 4/2) silt loam, light brownish gray (2.5Y 6/2) dry; moderate medium subangular blocky structure; slightly hard, friable, sticky and plastic; many roots; medium acid (pH 5.8); abrupt irregular boundary. ((; to 8 inches thick)

B&A-14 to 27 inches; grayish brown (10YR 5/2) silty clay, light brownish gray (2.5Y 6/2) dry; common medium distinct yellowish brown (10YR 5/6) mottles; strong coarse prismatic structure; very hard, very firm, very sticky and very plastic; few wiry fine roots along ped faces; light gray (10YR 6/1) silt loam thick coatings of A2 material on ped surfaces; the A2 occupies about 30 percent of this horizon; few very fine pores; common moderately thick clay films on peds; medium acid (pH 5.8); gradual wavy boundary. (10 to 20 inches thick)

B21t-27 to 36 inches; grayish brown (10YR 5/2) silty clay, light brownish gray (2.5Y 6/2) dry; common medium prominent yellowish brown (10YR 5/6) mottles; common medium prominent black (10YR 2/1) manganese coatings; strong coarse and moderate coarse prismatic structure; very hard, very firm, very sticky and plastic; very few very fine roots along ped faces; light *gray* (10YR 6/1) thick continuous coatings of A2 material on ped surfaces and in pores; few very fine pores; many moderately thick clay films on peds; medium acid (pH 6.0); abrupt smooth boundary. (8 to 15 inches thick)

IICg-36 to 60 inches; dark grayish brown (10YR 4/2) silty clay, light brownish gray (10YR 6/2) dry; massive; very hard, very firm, very sticky and very plastic; 15 percent cobbles and gravel; medium acid (pH 6.0).

The control section is 8 to 15 percent coarse fragments. Many mottled pebble- and cobblestone-sized fragments are extremely weathered and are easily cut by a knife. Stones and cobbles are randomly scattered. The A horizon has value of 5 or 6 dry and chroma of 2 or 3 moist or dry. Texture is silt loam or silty clay loam. The B2t horizon ha; value of 4 or 5 moist and 5 through 7 dry and chroma of 2 moist or dry. It has distinct to prominent yellowish brown mottles. The A2 horizon tongues into the B horizon.

Semiahmoo series

The Semiahmoo series consists of very poorly drained soils that formed in decaying plant remains. Semiahmoo soils are in depressions of river valleys and their tributaries. They have slopes of 0 to 1 percent. The mean annual precipitation is 35 to 50 inches, and the mean annual air temperature is about 50 degrees F.

Typical pedon of Semiahmoo muck, 200 feet west and 2,250 feet north of southeast corner of section 14, T. 20 N., R. 4 E.:

Oap-0 to 6 inches; black (5YR 2/1) sapric material, dark gray (10YR 4/1) dry; about 12 percent fiber, less than 5 percent rubbed; moderate fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine and fine roots; strongly acid (pH 5.2); clear smooth boundary. (4 to 10 inches thick)

Oa1-6 to 12 inches; black (5YR 2/1) sapric material, dark gray (10YR 4/1) dry; about 12 percent fiber, less than 5 percent rubbed; strong medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine .1.nd fine roots; few very fine pores; strongly acid (pH 5.2); abrupt smooth boundary. (0 to 10 inches thick)

Oa2-12 to 22 inches; dark reddish brown (5YR 2/2) saparic material, dark grayish brown (10YR 4/2) dry; about 60 percent fibers, 12 percent rubbed; very thin platy structure; very thin discontinuous layers of silt loam or silty clay; hard, very friable, nonsticky and slightly plastic; common very fine and fine roots; few fine pores; strongly acid (pH 5.2); abrupt smooth boundary. (8 to 40 inches thick)

Oa3-22 to 35 inches; black (5YR 2/1) sapric material, dark gray (10YR 4/1) dry; 40 percent fibers, less than 12 percent rubbed; very thin platy structure; hard, very friable, nonsticky and slightly plastic; few fine roots; few fine pores; strongly acid (pH 5.1); abrupt smooth boundary. (0 to 20 inches thick)

Oa4-35 to 53 inches; very dark brown (10YR 2/2) sapric material, dark grayish brown (10YR 4/2) dry; about 60 percent fibers, less than 15 percent rubbed; massive; hard, very friable, nonsticky and slightly plastic; few fine roots; few fine pores; very strongly acid (pH 5.0); abrupt smooth boundary. (thickness is variable).

IICg-53 to 61 inches; dark grayish brown (10YR 4/2) silty clay, light brownish gray (10YR 6/2) dry; massive; very hard, firm, sticky and plastic; few herbaceous and woody fibers; very strongly acid (pH 5.0); abrupt smooth boundary. (thickness is variable)

Oe1-61 to 65 inches; dark reddish brown (5YR 2/2) on broken face and rubbed; heroic material; massive; hard, very friable, nonsticky and slightly plastic; slightly acid (pH 6.4).

Fibers are mostly from grasses and sedges but may include up to 5 percent wood. The soil profile is dominanted by sapric material. Fiber content ranges from 20 to 60 percent and 5 to 15 percent rubbed. When moist, tiers have hue of 5YR, 7.5YR, or 10YR and value and chroma of 1 or 2. The bottom tier is generally higher in fiber content and is stratified with very thin layers of silty clay or silty clay loam.

Shalcar series

The Shalcar series consists of very poorly drained soils that formed in decaying plant remains and alluvium. Shalcar soils are in depressions in valleys of rivers and their tributaries. They have slopes of 0 to 1 percent. The mean annual precipitation is 35 to 45 inches, and the mean annual air temperature is about 50 degrees F.

Typical pedon of Shalcar muck, 2,200 feet south and 10 feet east of the northwest corner of section 7, T. 20 N., R. 5 E.:

Oap-0 to 6 inches; dark reddish brown (5YR 2/2) sapric material, reddish brown (5YR 4/3) dry, dark reddish brown (5YR 2/2) rubbed and pressed; about 15 percent fiber, less than 5 percent rubbed; moderate fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine roots; medium acid (pH 5.6); clear smooth boundary. (6 to 9 inches thick)

Oa1-6 to 12 inches; dark reddish brown (5YR 2/2) sapric material, reddish brown (5YR 4/3) dry, dark reddish brown (5YR 2/2) rubbed and pressed; about 10 percent fiber, less than 4 percent rubbed; moderate, medium, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; medium acid (pH 5.8); abrupt smooth boundary. (5 to 7 inches thick)

C1-12 to 17 inches; dark grayish brown (10YR 4/2) silty clay, light grayish brown (10YR 6/2) dry; finely stratified; hard, very firm, sticky and plastic; common very fine and fine roots; few very fine pores; medium acid (pH 5.8); clear smooth boundary. (4 to 6 inches thick)

C2-17 to 27 inches; dark brown (10YR 4/3) silty clay, pale brown (10YR 6/3) dry; massive; hard, very firm, sticky and plastic; common very fine and fine roots; few very fine pores; medium acid (pH 6.0); abrupt smooth boundary. (8 to 12 inches thick)

Oe-27 to 46 inches; black (10YR 2/1) hemic material, very dark brown (10YR 2/2) dry, dark reddish brown (5YR 2/2) rubbed and pressed; about 35 percent fiber, less than 10 percent rubbed; stratified; slightly hard, friable, nonsticky and nonplastic; common very fine roots; few very fine pores; very strongly acid (pH 5.0); abrupt smooth boundary. (12 to 24 inches thick)

C3-46 to 64 inches; very dark gray (10YR 3/1) fine sandy loam, gray (10YR 5/1) dry; massive; slightly hard, friable, nonsticky and non-plastic; few very fine roots; slightly acid (pH 6.2).

Organic layers below the Oap horizon are black (10YR 2/1). These layers are 10 to 45 percent fiber when unrubbed and less than 10 percent rubbed. The texture of the mineral horizons is silty clay, silt loam, very fine sandy loam, fine sandy loam, loamy sand, and sand.

Snohomish series

The Snohomish series consists of poorly drained soils that formed in alluvium and decaying plant remains. Snohomish soils are on flood plains and have slopes of 0 to 2 percent. The mean annual precipitation is 35 to 45 inches, and the mean annual air temperature is about 50 degrees F.

Typical pedon of Snohomish silty clay loam, 1,700 feet west and 2,600 feet north of southwest corner of section 13, T. 20 N., R. 4 E.:

Ap-0 to 9 inches; very dark grayish brown (10YR 3/2) silty clay loam, light gray (10YR 7/2) dry on ped faces and light brownish gray (10YR 6/2) dry; moderate fine and medium subangular blocky structure; hard, firm, sticky and plastic; few fine pores; medium acid (pH 5.6); gradual smooth boundary. (4 to 9 inches thick)

C1g-9 to 17 inches; very dark grayish brown (10YR 3/2) silty clay loam, light brownish gray (10YR 6/2) dry; strong medium subangular blocky structure; hard, firm, sticky and plastic; few fine pores; medium acid (pH 6.0); abrupt smooth boundary. (5 to 12 inches thick)

IIOe1-17 to 29 inches; dark reddish brown (5YR 2/2) sedimentary peat and thin strata of mineral material, very dark brown (10YR 2/2) dry; moderate medium platy structure; hard, very friable, nonsticky and nonplastic; estimated mineral content 30 percent; medium acid (pH 6.0); abrupt smooth boundary. (6 to 15 inches thick)

IIC2g-29 to 52 inches; gray (5Y 5/1) silty clay, light brownish gray (2.5Y 6/2) dry; massive; very hard, very firm, sticky and very plastic; slightly acid (pH 6.4); abrupt smooth boundary. (15 to 25 inches thick)

IIC3g-52 to 59 inches; very dark gray (5Y 3/1) fine sand;' loam, *gray*ish brown (2.5Y 5/2) dry; massive; slightly hard, friable, nonsticky and slightly plastic; neutral (pH 6.8); abrupt smooth boundary. (0 to 9 inches thick)

IIC4g-59 to 80 inches; greenish gray (5G 5/1) silty clay, light olive gray (5Y 6/2) dry; massive; very hard, very firm, sticky and very plastic; neutral (pH 6.8).

The A horizon has hue of 10YR or 2.5Y, value of 3 or 4 moist, and chroma of 1 or 2, and it is mottled in some pedons. It has moderate granular or blocky structure. The Cg horizon has hue of 10YR through 5Y or 5G and value of 3 through 5 moist. It ranges from silt loam to silty clay loam or silty clay. The organic layers are stratifie1, sedimentary wood and sedge peat, which total 10 inches or more in thickness.

Spana series

The Spana series consists of somewhat poorly drained soils that formed in alluvium containing volcanic ash over very gravelly alluvium. Spana soils are in depressions or troughs on plains and have slopes of 0 to 2 percent. The mean annual precipitation is 35 to 45 inches, and the mean annual air temperature is about 51 degrees F.

Typical pedon of Spana loam, 1,500 feet west and 2,800 feet north of southeast corner of section 27, T. 18 N., R. 3 E.:

A1-0 to 24 inches; very dark brown (10YR 212) loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; soft, very friable, slightly sticky and slightly plastic; many very fine roots; 15 percent gravel; medium acid (pH 5.8); abrupt smooth boundary. (20 to 28 inches thick)

B2-24 to 29 inches; very dark grayish brown (10YR 3/2) gravelly loam, grayish brown (10YR 5/2) dry; moderate medium subangular blocky structure; hard, firm, sticky and plastic; few very fine roots; 25 percent gravel and cobbles; medium acid (pH 6.0); clear smooth boundary. (3 to 7 inches thick)

IIC1-29 to 36 inches; dark grayish brown (10YR 4/2) very gravelly coarse sandy loam, light brownish gray (10YR 6/2) dry; massive; soft, very friable, nonsticky and nonplastic; few fine roots; 70 percent gravel and cobbles; medium acid (pH 6.0); clear smooth boundary. (7 to 15 inches thick)

IIC2-36 to 60 inches; dark grayish brown (10YR 4/2) very gravelly loamy sand, light brownish gray (10YR 6/2) dry; massive; loose; 70 percent gravel and cobbles; medium acid (pH 6.0).

Depth to very gravelly coarse sandy loam ranges from 23 to 30 inches. Coarse fragments in the control section average 35 to 50 percent. The umbric epipedon is 23 to 35 inches thick. The A1 horizon has value of 3 or 4 dry and chroma of 1 or 2 moist or dry. It is dominantly loam or sandy loam and has 10 to 20 percent coarse fragments. The B horizon has value of 3 or 4 moist. It has less than 35 percent clay and has 20 to 40 percent coarse fragments. It has faint or distinct, yellowish or strong brown mottles and has gravel cemented by iron in some pedons.

Spanaway series

The Spanaway series consists of somewhat excessively drained soils that formed in glacial outwash that is mixed in the upper part with volcanic ash. Spanaway soils are on terraces and have slopes of 0 to 6 percent. The mean annual precipitation is 35 to 45 inches, and the mean annual air temperature is about 51 degrees F.

Typical pedon of Spanaway gravelly sandy loam, east of Pacific Avenue and south of Spanaway in the SE1/4SW1/4 section 33, T. 19 N., R. 3 E.:

O2-1 inch to 0; black (10YR 2/1) well decomposed organic matter, very dark brown (10YR 2/2) dry; mostly from grass roots and moss. (1/2 to 1 1/2 inches thick)

A1-0 to 14 inches; black (10YR 2/1) gravelly sandy loam, very dark grayish brown (10YR 3/2) dry; weak fine granular structure; soft, very friable, nonsticky and nonplastic; many fine roots; very high in organic matter content, has mellow, sooty feel; 35 percent pebbles; strongly acid (pH 5.4); clear smooth boundary. (10 to 20 inches thick)

B2-14 to 18 inches; dark grayish brown (10YR 4/2) very gravelly sandy loam, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; common fine roots; 60 percent pebbles and cobbles; medium acid (pH 5.8); clear smooth boundary. (4 to 8 inches thick)

C-18 to 60 inches; light brownish gray (10YR 6/2) dry; very gravelly sand; single grained; loose; few roots; 70 percent pebbles and cobbles; slightly acid (pH 6.1).

Depth to very gravelly sand ranges from 14 to 28 inches. Content of coarse fragments in the control section averages 50 to 75 percent. These soils are usually moist, but they are dry between depths of 12 and 35 inches for about 70 to 80 consecutive days annually. The umbric epipedon is 10 to 20 inches thick. The A1 horizon has hue of 10YR through 5YR, value of 3 or 4 dry, and chroma of 1 or 2 dry. It is dominantly gravelly sandy loam or very gravelly sandy loam but includes very gravelly loam in some pedons. This horizon is medium acid or strongly acid. The B2 horizon has value of 4 or 5 dry and 3 or 4 moist. It is dominantly very gravelly sandy loam but includes very gravelly loamy sand in some pedons. This horizon is medium acid or slightly acid. The IIC horizon has hue of 10YR or 2.5Y, value of 5 or 6 dry and 4 or 5 moist, and chroma of 2 through 4 dry or moist. It is slightly acid or neutral.

Sultan series

The Sultan series consists of moderately well drained soils that formed in alluvium. Sultan soils are on flood plains and have slopes of 0 to 2 percent. The mean annual precipitation is 35 to 50 inches, and the mean annual air temperature is about 50 degrees F.

Typical pedon of Sultan silt loam, 1,900 feet north and 150 feet east of the southwest corner of sec. 17, T. 20 N., R. 4 E.:

Ap-0 to 7 inches; dark grayish brown (10YR 4/2) silt loam, pale brown (10YR 6/3) dry; moderate medium subangular blocky structure; friable, sticky and plastic; few fine roots; common very fine pores; slightly acid (pH 6.4); abrupt smooth boundary. ((; to 10 inches thick)

A12-7 to 14 inches; dark grayish brown (10YR 4/2) silt loam, pale brown (10YR 6/3) dry; moderate medium subangular blocky structure; friable, sticky and plastic; few fine roots; common very fine pores; slightly acid (pH 6.2); clear smooth boundary. (6 to 10 inches thick)

C1-14 to 23 inches; brown (10YR 4/3) silt loam, pale brown (10YR 6/3) dry; many medium prominent dark reddish brown (5YR 3/4) and very dark gray (10YR 3/1) mottles; moderate medium subangular blocky structure; friable, sticky and plastic; few very fine roots; common very fine, fine, and medium pores; few 2- to 5-milllimeter yellowish red (5YR 4/6) iron concretions; neutral (pH 6.8); clear smooth boundary. (7 to 10 inches thick)

C2-23 to 34 inches; dark yellowish brown (10YR 3/4) very fine sandy loam, light brownish gray (10YR 6/2) dry; many medium distinct brown (10YR 4/3) dark gray (10YR 4/1) and yellowish red (5YR 4/6) mottles; massive; friable, slightly sticky and slightly plastic; few very fine roots; many very fine pores; neutral (pH 6.8); clear smooth boundary. (10 to 14 inches thick)

C3-34 to 41 inches; dark gray (10YR 4/1) fine sandy loam, light brownish gray (1OYR 6/2) dry; massive; friable, nonsticky and nonplastic; common very fine pores; neutral (pH 6.8); very abrupt smooth boundary. (6 to 8 inches thick)

C4-41 to 44 inches; gray (10YR 5/1) silty clay loam, very pale brown (10YR 7/3) dry; many medium distinct dark yellowish brown (10YR 4/4) and reddish brown (5YR 4/4) mottles; laminated; firm, sticky and plastic; few very fine pores; neutral (pH 6.61; very abrupt smooth boundary. (2 to 4 inches thick)

C5-44 to 50 inches; very dark grayish brown (10YR 3/2) fine sand, grayish brown (10YR 5/2) dry; many medium distinct yellowish red (5YR 4/6) strong brown (7.5YR 4/6) and dark gray (AYR 4/1) mottles; massive; friable, nonsticky and nonplastic; few very fine pores; neutral (pH 6.8); very abrupt smooth boundary. (5 to 7 inches thick)

C6-50 to 60 inches; dark yellowish brown (10YR 4/4) silt loam, light gray (10YR 7/2) dry; many medium distinct yellowish red (5YR 4/6) mottles; massive; friable, sticky and plastic; few very fine pores; neutral (pH 6.8).

The control section averages less than 5 percent coarse fragments, less than 15 percent sand that is fine and coarser, and 13 to 25 percent clay. The profile is slightly acid to neutral throughout. Mottles are below a depth of 14 inches. The A horizon is dark grayish brown (10YR 4/2, 2.5Y 4/2). The C1 and C2 horizons are dark yellowish brown (10YR 3/4) and brown (10YR 4/3) and have many medium dark reddish brown (5YR 3/4), brown (7.5YR 5/4, 10YR 4/3), very dark gray (10YR 3/1), and dark gray (10YR 4/1) mottles. Texture is silt loam, loam, or very fine sandy loam. The C5 and C6 horizons are dark gray (10YR 4A), gray (10YR 5/1), and very dark grayish brown (10YR 3/2, 2.5Y 3/2) aid are mottled. They are stratified with layers of fine sand, fine sandy loam, silt loam, and silty clay loam.

Tacoma series

The Tacoma series consists of very poorly drained soils that formed in alluvium and decaying plant remains. Tacoma soils are on deltas and have slopes of 0 to 1 percent. The mean annual precipitation is 35 to 45 inches, and the mean annual air temperature is about 50 degrees F.

Typical pedon of Tacoma silt loam, on Anderson Island, 3,250 feet west and 2,100 feet south of northeast corner of sec. 8, T. 19 N., R. 1 E.:

A1-0 to 4 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; moderate fine subangular blocky structure; hard, firm, slightly sticky and slightly plastic; many fine and very fine roots; many fine and very fine pores; strongly acid (pH 5.4); abrupt smooth boundary. (3 to 6 inches thick)

C1g-4 to 14 inches, dark grayish brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) dry; few fine distinct reddish brown (2.5YR 4/4) mottles; moderate coarse prismatic structure; hard, firm, slightly sticky and plastic; common very fine and fine roots; many very fine and fine pores; strongly acid (pH 5.5); abrupt smooth boundary. (7 to 20 inches thick)

C2g-14 to 23 inches; very dark gray (10YR 3/1) silty clay, gray (10YR 5/1) dry; common medium distinct mottles; massive breaking to strong coarse subangular blocky structure; very hard, firm, very sticky and very plastic; common very fine and fine roots; few very fine pores; hard dark red (2.5YR 3/6) iron casts along root channels; strongly acid (pH 5.9); abrupt smooth boundary. (8 to 11 inches thick)

IIC3g-23 to 32 inches; dark gray (10YR 4/1) silt (diatomaceous earth), gray (10YR 6/1) dry; massive; very hard, very firm, sticky and plastic; common very fine and fine roots; few very fine pores; strongly acid (pH 5.4); abrupt smooth boundary. (8 to 11 inches thick)

IIC4g-32 to 59 inches; light brownish gray (10YR 6/2) silt (diatomaceous earth), white (10YR 8/1) dry; massive; hard, firm, sticky and plastic; strongly acid (pH 5.5); abrupt smooth boundary. (20 to 30 inches thick)

IIC5g-59 to 79 inches; dark grayish brown (10YR 4/2) stratified layers of silt (diatomaceous earth) and sedimentary peat, light brownish gray (10YR 6/2) dry; massive; very hard, firm, sticky and plastic; strongly acid (pH 5.5).

These soils are saturated with water and have a water table near the surface during the winter months unless artificially drained. In some pedons there are layers of muck, 1 to 5 inches thick, that have a combined thickness of less than 16 inches. The Al horizon has hue of 10YR, value of 3 or 4 moist and 5 or 6 dry, and chroma of 1 or 2 moist and dry. The C horizon has hue of 10YR or 5Y, moist value of 3 to 5, and chroma of 1 or 2. Mottles range from faint to prominent. The IICg horizon has hue of 2.5Y or 10YR, moist value of 4 through 6, and chroma of 1 or 2. They are stratified with diatomaceous silt, sedimentary peat, clay, and sand.

Tanwax series

The Tanwax series consists of very poorly drained soils that formed in sedimentary peat. Tanwax soils are in basins and ponded areas in old stream valleys and have slopes of 0 to 1 percent. The mean annual precipitation is 35 to 70 inches, and the mean annual air temperature is about 49 degrees F.

Typical pedon of Tanwax muck, north of Ohop Lake, 2,200 feet west and 1,000 feet north of the southeast corner of section 35, T. 17 N., R. 4 E.:

Lco1-0 to 15 inches; very dark grayish brown (10YR 3/2) sedimentary peat; 5 percent wood fiber, less than 1 percent rubbed; moderate medium subangular blocky structure; friable; common very fine and medium pores; strongly acid (pH 5.5); clear smooth boundary. (5 to 20 inches thick)

Lco2-15 to 60 inches; very dark grayish brown (10YR 3/2) sedimentary peat; 15 to 25 percent wood fiber; less than 10 percent rubbed; breaks into thin layers; medium acid (pH 6.0).

The depth of the sedimentary peat is more than 15 feet. The soils are usually saturated with water. Fibers are mostly from spirea, alder, and grass. The control section is dominantly sedimentary peat. Finer content ranges from 5 to 40 percent; it is less than 10 percent rubbed. The tiers have hue of 10YR, value of 2 through 4, and chroma of 1 or 3. The upper part of the surface tier in places has distinct, dark reddish brown (5YR 3/4) or dark brown (7.5YR 3/4) mottles.

Tisch series

The Tisch series consists of very poorly drained soils that formed mainly in diatomaceous earth, volcanic ash, and decaying plant remains. Tisch soils are in upland basins and drainageways and have slopes of 0 to 1 percent. The mean annual precipitation is 35 to 60 inches, and the mean annual air temperature is about 50 degrees F.

Typical pedon of Tisch silt, 2,070 feet east and 100 feet south of northwest corner of section 7, T. 17 N., R. 4 E.:

Ap-0 to 7 inches; very dark brown (10YR 2/2) silt, grayish brown (10YR 5/2) dry; weak fine and medium granular structure and weak medium platy; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; medium acid (pH 6.0); clear smooth boundary. (6 to 8 inches thick)

A3-7 to 12 inches; very dark grayish brown (10YR 3/2) Silt, grayish brown (10YR 5/2) dry; moderate, medium, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; medium acid (pH 6.0); abrupt smooth boundary. (5 to 8 inches thick)

C1-12 to 17 inches; very dark grayish brown (10YR 3/2) silt, light brownish gray (10YR 6/2) dry; few fine distinct dark brown (7.5YR 4/4) mottles; moderate, coarse, prismatic structure; slightly hard, firm, slightly sticky and slightly plastic; many very fine roots; common fine and very fine pores; organic deposits in fine pores and along root channels; slightly acid (pH 6.2); clear smooth boundary. (5 to 7 inches thick)

C2-17 to 26 inches; dark grayish brown (10YR 4/2) silt, light gray (10YR 7/2) dry; weak thick platy structure; slightly hard, firm, slightly sticky and slightly plastic; many very fine roots; common very fine and fine pores; organic deposits in pores and along root channels; slightly acid (pH 6.4); abrupt broken boundary. (0 to 10 inches thick)

C3-26 to 28 inches; brown (10YR 4/3) silt (pumicite), very pale brown (10YR 7/3) dry; massive; slightly hard, firm, slightly sticky and slightly plastic; common very fine roots; common very fine and fine pores; organic deposits in pores and along root channels; slightly acid (pH 6.4); abrupt smooth boundary. (0 to 3 inches thick)

C4-28 to 55 inches; very dark brown (10YR 2/2) silt, grayish brown (10YR 5/2) dry; massive; slightly hard, firm, slightly sticky and slightly plastic; few very fine roots; common very fine pores; organic deposits in pores and along root channels; slightly acid (pH 6.2); abrupt smooth boundary. (20 to 30 inches thick)

C5-55 to 65 inches; black (10YR 2/1) and very dark brown (10YR 2/2) muck, dark grayish brown (10YR 4/2) dry; finely laminated; hard, friable, slightly sticky and slightly plastic; few very fine pores; medium acid (pH 5.8).

The A horizon has hue of 5YR through 10YR and chroma of 1 or 2 moist and dry. The A horizon contains as much as 20 percent organic matter. The C horizon has chroma of 1 to 4 moist and dry. Some pedons do not have thin layers of volcanic ash or pumice in the C horizon, and some pedons have peat layers below a depth of 30 inches.

Wilkeson series

The Wilkeson series consists of well drained soils that formed in weathered andesite and basalt. Wilkeson soils are on the foothills of the Cascade Mountains and have slopes of 6 to 65 percent. The mean annual precipitation is 70 to 90 inches, and the mean annual air temperature is about 46 degrees F.

Typical pedon of Wilkeson gravelly silt loam, 45 to 65 percent slopes, 1,700 feet east and 1,600 feet south of the northwest corner of section 21, T. 17 N., R. 5 E.:

A1-0 to 4 inches; very dark grayish brown (10YR 3/2) gravelly silt loam, grayish brown (10YR 5/2) dry; weak very fine subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; common very fine roots; 25 percent shot and angular pebbles; medium acid (pH 5.6); abrupt smooth boundary. (3 to 5 inches thick)

B11-4 to 10 inches; dark brown (10YR 3/3) gravelly silt loam, brown (10YR 5/3) dry; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and plastic; many fine, medium and coarse roots; 30 percent shot and angular pebbles; strongly acid (pH 5.4); diffuse wavy boundary. (5 to 7 inches thick)

B12-10 to 18 inches; brown (10YR 4/3) gravelly silt loam, brown (10YR 5/3) dry; weak fine subangular blocky structure; hard, firm, sticky and plastic; many fine medium and coarse roots; 20 percent shot and angular pebbles; strongly acid (pH 5.4); clear wavy boundary. (7 to 9 inches thick)

B21t-18 to 27 inches; dark yellowish brown (10YR 4/4) gravelly silty clay loam, pale brown (10YR 6/3) dry; moderate medium subangular blocky structure; hard, firm, sticky and plastic; many fine medium and coarse roots; common very fine and fine pores; thin patchy clay films in pores; 20 percent shot and angular pebbles; strongly acid (pH 5.4); diffuse wavy boundary. (8 to 12 inches thick)

B22t-27 to 36 inches; yellowish brown (10YR 5/4) gravelly silty clay loam, light yellowish brown (10YR 6/4) dry; moderate medium prismatic structure parting to moderate medium subangular blocky; hard, firm, sticky and plastic; few fine and coarse roots; common very fine and fine pores; moderate thick clay films in fine pores; 10 percent angular pebbles; medium acid (pH 5.8); gradual wavy boundary. (8 to 15 inches thick)

B31-36 to 49 inches; dark yellowish brown (10YR 4/4) loam, yellowish brown (10YR 5/6), light yellowish brown (10YR 6/4), and pale brown (10YR 6/3) dry; moderate medium subangular blocky structure; hard, firm, sticky and plastic; few fine roots; common very fine and fine pores; thick clay films on peds and in very fine pores; 10 percent angular pebbles; medium acid (pH 5.8); diffuse wavy boundary. (7 to 14 inches thick)

B32-49 to 64 inches; yellowish brown (10YR 5/4) gravelly loam, light reddish brown (2.5Y 6/4), very pale brown (10YR 7/3) light yellowish brown (10YR 6/4), and brownish yellow (10YR 6/6) dry; rock structure; hard, firm, sticky and plastic; few fine roots; few very fine and fine pores; thick clay films on peds and in very fine pores; 15 percent angular pebbles; medium acid (pH 6.0).

The soils are usually moist and are not dry in all parts for as much as 60 consecutive days or in some part for as much as 90 cumulative days in most years. The control section averages less than 35 percent, by volume, coarse fragments, 25 to 35 percent clay, and less than 15 percent sand that is fine and coarser. Depth to bedrock exceeds 40 inches. The A horizon has chroma of 2 or 3 moist and dry. The B2t horizon has hue of 10YR or 7.5YR, value of 5 or 6 dry, and chroma of 3 or 4 moist or dry. It is gravelly silt loam or gravelly silty clay loam. The B3 horizon has hue of 10YR, 7.5YR, and 2.5YR, value of 5 through 7 dry, and chroma of 3 through 6 dry. Some pedons have a C horizon that contains strongly weathered andesite or basalt.

Classification

The system of soil classification currently used was adopted by the National Cooperative Soil Survey in 1965. Readers interested in further details about the system should refer to "Soil taxonomy" *(6, 8).*

The system of classification has six categories. Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. In this system the classification is based on the different soil properties that can be observed in the field or those that can be inferred either from other properties that are observable in the field or from the combined data of soil science and other disciplines. The properties selected for the higher categories are the result of soil genesis or of factors that affect soil genesis. In table 13, the soils of the survey area are classified according to the system. Categories of the system are discussed in the following paragraphs.

ORDER. Ten soil orders are recognized as classes in the system. The properties used to differentiate among orders are those that reflect the kind and degree of dominant soil-forming processes that have taken place. Each order is identified by a word ending in *sol.* An example is Entisol.

SUBORDER. Each order is divided into suborders based primarily on properties that influence soil genesis and are important to plant growth or that are selected to reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Aquent *(Aqu,* meaning water, plus *ent,* from Entisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of expression of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and a prefix that suggests something about the properties of the soil. An example is Haplaquents *(Hapl,* meaning simple horizons, plus *aquent,* the suborder of Entisols that have an aquic moisture regime).

SUBGROUP. Each great group may be divided into three subgroups: the central (typic) concept of the great groups, which is not necessarily the most extensive subgroup; the intergrades, or transitional forms to other orders, suborders, or great groups; and the extragrades, which have some properties that are representative of the great groups but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that is thought to typify the great group. An example is Typic Haplaquents.

FAMILY. Families are established within a subgroup on the basis of similar physical and chemical properties that affect management. Among the properties considered in horizons of major biological activity below plow depth are particle-size distribution, mineral content, temperature regime, thickness of the soil penetrable by roots, consistence, moisture equivalent, soil slope, and permanent cracks. A family name consists of the name of a subgroup and a series of adjectives. The adjectives are the class names for the soil properties used as family differentiae. An example is fine-loamy, mixed, nonacid, mesic, Typic Haplaquents.

SERIES. The series consists of soils that formed in a particular kind of material and have horizons that, except for texture of the surface layer or of the underlying substratum, are similar in differentiating characteristics and in arrangement in the soil profile. Among these characteristics are color, texture, structure, reaction, consistence, and mineral and chemical composition.

Climate

The climate of Pierce County is greatly tempered by winds from the Pacific Ocean. Summers are fairly warm, but hot temperatures are not common except at higher elevations. During summer rainfall is extremely light, so crops growing actively during this period need irrigation. Often several weeks pass without precipitation. During the rest of the year rains are frequent, especially late in fall and in winter.

Tables 14 and 15 give data on temperature and precipitation for the survey area, as recorded at Puyallup and Electron Headworks, Washington, for the period 1951 to 1974. Tables 16 and 17 show probable dates of the first freeze in fall and the last freeze in spring. Tables 18 and 19 provide data on length of the growing season. The climate at Puyallup is typical of the climate at low elevations in the western part of the county, and the climate at Electron Headworks is typical of the climate on the cooler and wetter slopes of the Cascade Mountains.

In the west, in winter the average temperature is 40.5 degrees F, and the average daily minimum is 33.1 degrees. The lowest temperature on record, 0 degrees, occurred at Puyallup Experiment Station on November 15, 1955. In summer the average temperature is 62.9 degrees and the average daily maximum is 76.4 degrees. The highest temperature, 101 degrees, was recorded on June 9, 1955.

On mountain slopes, in winter the average temperature is 35.9 degrees and the average daily minimum is 29.9 degrees. The lowest temperature on record, -3 degrees, occurred at Electron Headworks on December 8, 1972. In summer the average temperature is 58.3 degrees and the average daily maximum is 71.4 degrees. The highest temperature, 96 degrees, was recorded on July 19, 1956.

Growing degree days, shown in Table 14, are equivalent to `heat units.' Beginning in spring, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (40 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

Of the total annual precipitation, about 25 percent usually falls during the period April through September, which includes the growing season for most c:-ops. This seasonal precipitation is about 10 inches in the west and 20 inches on the slopes. Two years in 10, the April-September rainfall is less than 8 and 15 inches, respectively. The heaviest 1-day rainfall during the period of record was 3.28 inches at Puyallup and 4.46 inches at Electron Headworks. Thunderstorms number about six each year, three of which occur in summer.

Average seasonal snowfall is 10 inches in the west and 47 inches on the slopes. The greatest snow depth at any one time during the period of record was 35 inches. On the average, 3 and 17 days, respectively, have at least 1 inch of snow on the ground, but the number of days varies greatly from year to year.

In most winters, one or two storms over the whole county bring strong and sometimes damaging winds, and in some years the accompanying heavy rains cause serious flooding. Every few years, either in winter or in summer, a large invasion of a continental airmass from the east causes abnormal temperatures. In winter several consecutive days have temperatures well below freezing; in summer a week or longer has sweltering weather.

In the west, the average relative humidity in midafternoon in spring is less than 72 percent; during the rest of the year it is about 75 percent. Humidity is higher at night in all seasons, and the average at dawn is about 80 percent. The percentage of possible sunshine is 63 percent in summer and 51 percent in winter. The prevailing direction of the wind is from the southwest.. Average windspeed is highest, 10.4 miles per hour, in January.

On the slopes, the average relative humidity in midafternoon in spring is less than 58 percent; during the rest of the year it is about 66 percent. Humidity is higher at night in all seasons, and the average at dawn is about 80 percent. The percentage of possible sunshine is 56 percent in summer and 47 percent in winter. The prevailing direction of the wind is from the south-southwest. Average windspeed is highest, 7.7 miles per hour, in January.

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Glossary

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim. An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Available water capacity. The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as

	Inches
Low	Less than 3.75 inches
Moderate	3.75-7.5 inches
High	More than 7.5 inches

Badland. Steep or very steep, commonly nonstony barren land dissected by many intermittent drainage channels. Badland is most common in semiarid and arid regions where streams are entrenched in soft geologic material. Local relief generally ranges from 25 to 500 feet. Runoff potential is very high, and geologic erosion is active.

Base saturation. The degree to which material having base exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the exchange capacity.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bottom land. The normal flood plain of a stream, subject to frequent flooding.

Cation. An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with baseexchange capacity, but is more precise in meaning.

CMAI. Culmination mean annual increment.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coat, clay skin.

Coarse fragments. Mineral or rock particles up to 3 inches (2 millimeters to 7.5 centimeters) in diameter.

Cobblestone (or cobble). A rounded or partly rounded fragment of rock 3 to 10 inches (7.5 to 25 centimeters) in diameter.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the bases of steep slopes.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures is difficult.

Complex, soil. A mapping unit of two or more kinds of soil occurring in such an intricate pattern that they cannot be shown separately on a soil map at the selected scale of mapping and publication.

Compressible. Excessive decrease in volume of soft soil under load.

Concretions. Hardened local concentrations of chemical compounds that form indurated nodules, grains, or pellets of various sizes, shapes, and colors. Calcium carbonate, iron oxide, and manganese oxide are common compounds in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are

Loose.-Noncoherent when dry or moist; does not hold together in a mass.

Friable.-When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.-When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.-When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.-When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.-When dry, moderately resistant to pressure; (an be broken with difficulty between thumb and forefinger.

Soft.-When dry, breaks into powder or individual grains under very slight pressure.

Cemented.-Hard; little affected by moistening.

Contour tillage. Plowing, cultivating and planting on the contour.

Cross-slope farming. Plowing, cultivating, planting, and harvesting across the general slope, but not on the contour as in contour farming.

Control section. The part of the soil on which classification of moisture regime, particle size, mineralogy, series differentia, and other selected soil characteristics is based. The thickness varies among different kinds of soil.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cutbanks cave. Unstable walls of cuts made by earthmoving equipment. The soil sloughs easily.

Depth to rock. Bedrock at a depth that adversely affects the specified use.

Diatomaceous earth. A friable earthy deposit of nearly pure silica and consisting essentially of the frustules of the microscopic plants called diatoms.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.-Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.-Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.-Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.-Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically for long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.-Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.-Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.-Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients, as for example in "hillpeats" and "climatic moors.

Drainage, surface. Runoff, or surface flow of water, from an area.

Duripan. A subsurface horizon that is cemented by silica to the degree that fragments from the air-dry horizon do not slake during prolonged soaking in water or hydrochloric acid.

Erosion. The wearing away of the land surface by running water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes a bare surface.

Erosion hazard. Susceptibility to water or wind erosion. The terms used in this survey are slight, moderate, severe, and very severe. These terms are relative and apply only in relation to other soils of the Pierce County Area.

Excess fines. Excess silt and clay. The soil does not provide a source of gravel or sand for construction purposes.

Fast intake. The rapid movement of water into the soil.

Favorable. Favorable soil features for the specified use.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Fibric soil material (peat). The least decomposed of all organic soil material. Peat contains a large amount of well preserved fiber that is readily identifiable according to botanical origin. Peat has the lowest bulk density and the highest water content at saturation of all organic soil material.

First bottom. The normal flood plain of a stream, subject to frequent or occasional flooding.

Flooding. The temporary covering of soil with water from overflowing streams, runoff from adjacent slopes, and tides. Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *occasional* that it occurs on an average of once or less in 2 years; and *frequent* that it occurs on an average of more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; *November-May*, for example, means that flooding can occur during the period November through May. Water standing for short periods after rainfall or commonly covering swamps and marshes is not considered flooding.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Forage. Plant material used as feed by domestic animals. Forage can be grazed or cut for hay.

Forb. Any herbaceous plant not a grass or a sedge.

Frost action. Freezing and thawing of soil moisture. Frost action can damage structures and plant roots.

Glacial drift (geology). Pulverized and other rock material transported by glacial ice and then deposited. Also the assorted and unassorted material deposited by streams flowing from glaciers.

Glacial outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by melt water as it flows from glacial ice.

Glacial till (geology). Unassorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Gleyed soil. A soil having one or more neutral gray horizons as a result of waterlogging and lack of oxygen. The term "gleyed" also designates gray horizons and horizons having yellow and gray mottles as a result of intermittent waterlogging.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or subrounded fragments of rock or mineral up to 3 inches (2 millimeters to 7.5 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material from 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flat.ened, up to 3 inches (7.5 centimeters) in diameter.

Green manure (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table, which is the upper limit of saturation.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Habitat. The natural abode of a plant or animal; refers to the kind of environment in which a plant or animal normally lives, as opposed to the range or geographical distribution.

Hardpan. A hardened or cemented soil horizon, or layer. The soil material is sandy, loamy, or clayey and is cemented by iron oxide, silica, calcium carbonate, or other substance.

Hemic soil material (mucky peat). Organic soil material intermediate in degree of decomposition between the less decomposed fabric and the more decomposed sapric material.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. The major horizons of mineral soil are as follows:

O horizon.-An organic layer, fresh and decaying plant residue, at the surface of a mineral soil.

A horizon.-The mineral horizon, formed or forming at or near the surface, in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon most of which was originally part of a B horizon.

A2 horizon.-A mineral horizon, mainly a residual concentration of sand and silt high in content of resistant minerals as a result of the loss of silicate clay, iron, aluminum, or a combination of these.

B horizon.-The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or a combination of these; (2) by prismatic or blocky structure; (3) by redder or browner colors than those in the A horizon; or (4) by a combination of these. The combined A and B horizons are generally called the solum. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.-The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that from which the solum is presumed to have formed. If the material is known to differ from that in the solum the Roman numeral II precedes the letter C.

R layer.-Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Impervious soil. A soil through which water, air, or roots penetrate slowly or not at all. No soil is absolutely impervious to air and water all the time.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Irrigation**.** Application of water to soils to assist in production of crops. Methods of irrigation are

Border.-Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Basin.-Water is applied rapidly to nearly level plains surrounded by levees or dikes.

Controlled flooding.-Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Corrugation.-Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

Furrow.-Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

Sprinkler.-Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Subirrigation.-Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

Wild flooding.-Water, released at high points, is allowed to flow onto an area without controlled distribution.

Lacustrine deposit (geology). Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Landslide. The rapid downhill movement of a mass of soil and loose rock generally when wet or saturated. The speed and distance of movement, as well as the amount of soil and rock material, vary greatly.

Large stones. Rock fragments 10 inches (25 centimeters) or more across. Large stones adversely affect the specified use.

Leaching. The removal of soluble material from soil or other material by percolating water.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Low strength. Inadequate strength for supporting loads.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is greater than that of organic soil.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance-few, *common,* and *many;* size *fine, medium,* and *coarse;* and contrast-*faint, distinct,* and *prominent.* The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium,* from 5 to 15 millimeters (about 02 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Muck. Dark colored, finely divided, well decomposed organic soil material mixed with mineral soil material. The content of organic matter is more than 20 percent.

Munsell notation. A designation of color by degrees of the three single variables--hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4

Neutral soil**.** A soil having a pH value between 6.6 and 7.3

Nutrient, plant. Any element taken in by a plant, essential to its growth, and used by it in the production of food an(. tissue. Plant nutrients are nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, zinc, and perhaps other elements obtained from the soil; and carbon, hydrogen, and oxygen obtained largely from the air and water.

Organic matter. A general term for plant and animal material, in or on the soil, in all stages of decomposition. Readily decomposed organic matter is often distinguished from the more stable forms that are past the stage of rapid decomposition.

Outwash, glacial. Stratified sand and gravel produced by glaciers and carried, sorted, and deposited by water that originated mainly from the melting of glacial ice. Glacial outwash is commonly in valleys on landforms known as valley trains, outwash terraces, eskers, kame terraces, kames, outwash fans, or deltas.

Outwash plain. A land form of mainly sandy or coarse textured material of glaciofluvial origin. An outwash plain is commonly smooth; where pitted, it is generally low in relief.

Pan. A compact, dense layer in a soil. A pan impedes the movement of water and the growth of roots. The word "pan" is commonly combined with other words that more explicitly indicate the nature of the layer; for example, *hardpan*, *fragipan, claypan, plowpan*, and *traffic pan*.

Parent material. The great variety of unconsolidated organic and mineral material in which soil forms. Consolidated bedrock is not yet parent material by this concept.

Peat. Unconsolidated material, largely undecomposed organic matter, that has accumulated under excess moisture.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil. Percolation. The downward movement of water through the soil.

Percs slowly. The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality that enables the soil to transmit water or air, measured as the number of inches per hour that water moves through the soil. Terms describing permeability are *very slow* (less than 0.06 inch), *slow* (0.06 to 020 inch), *moderately slow* (02 to 0.6 inch), *moderate* (0.6 to 2.0 inches), *moderately rapid* (2.0 to 6.0 inches), *rapid* (6.0 to 20 inches), and *very rapid* (more than 20 inches).

Phase, soil. A subdivision of a soil series or other unit in the soil classification system based on differences in the soil that affect its management. A soil series, for example, may be divided into phases on the bases of differences in slope, stoniness, thickness, or some other characteristic that affects management. These differences are too small to justify separate series.

pH value. (See Reaction, soil). A numerical designation of acidity and alkalinity in soil

Piping. Formation by moving water of subsurface tunnels or pipelike cavities in the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from a semisolid to a plastic state.

Plowpan. A compacted layer formed in the soil directly below the plowed layer.

Polypedon. A volume of soil having properties within the limits of a soil series, the lowest and most homogeneous category of soil taxonomy. A "soil individual."

Poorly graded. Refers to soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Poor outlets. Surface or subsurface drainage outlets difficult or expensive to install.

Productivity (soil). The capability of a soil for producing a specified plant or sequence of plants under a specified system of management. Productivity is measured in terms of output, or harvest, in relation to input.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as

	pH
Extremely acid	Below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Regolith. The unconsolidated mantle of weathered rock and soil material on the earth's surface; the loose earth material above the solid rock. Soil scientists regard as soil only the part of the regolith that is modified by organisms and other soil-building forces. Most engineers describe the whole regolith, even to a great depth, as "soil."

Relief. The elevations or inequalities of a land surface, considered collectively.

Residuum (residual soil material). Unconsolidated, weathered, or partly weathered mineral material that accumulates over disintegrating rock.

Rill. A steep sided channel resulting from accelerated erosion. A rill is generally a few inches deep and not wide enough to be an obstacle to farm machinery.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rooting depth. Shallow root zone. The soil is shallow over a layer that greatly restricts roots. See Root zone.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged in stream channels from a drainage area. The water that flows off the land surface without sinking in is called surface runoff; that which enters the ground before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sapric soil material (muck). The most highly decomposed of all organic soil material. Muck has the least amount of plant fiber, the highest bulk density, and the lowest water content at saturation of all organic soil material.

Seepage. The rapid movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils, formed from a particular type of parent material, having horizons that, except for the texture of the A or surface horizon, are similar in all profile characteristics and in arrangement in the soil profile. Among these characteristics are color, texture, structure, reaction, consistence, and mineralogical and chemical composition.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and runoff water.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silica. A combination of silicon and oxygen. The mineral form is called quartz.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75 feet.

Slow intake. The slow movement of water into the soil.

Slow refill. The slow filling of ponds, resulting from restricted permeability in the soil.

Small stones. Rock fragments 3 to 10 inches (7.5 to 25 centimeters) in diameter. Small stones adversely affect the specified use.

Soil. A natural, three-dimensional body at the earth's surface that is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. Tie names and sizes of separates recognized in the United States are as follows: *very coarse sand* (2.0 millimeters to 1.0 millimeter); *coarse sand* (1.0 to 0.5 millimeter); *medium sand* (0.5 to 0.25 millimeter); *fine sand* (0.25 to 0.10 millimeter); *very fine sand* (0.10 to 0.05 millimeter); *silt* (0.05 to 0.002 millimeter); and *clay* (less than 0.002 millimeter).

Soil slope**.** Upward or downward inclination of the soil surface. Percentage of slope is the vertical distance divided by horizontal distance multiplied by 100.

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in mature soil consists of the A and B horizons. Generally, the characteristic of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristic of the soil are largely confined to the solum.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Stratified. Arranged in strata, or layers. The term refers to geologic material Layers in soils that result from the processes of soil formation are called horizons; those inherited from the parent material are called strata.

Structure, soil. The combination or arrangement of primary soil particles into secondary particles or peds. The principal forms of soil structure *are-platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage).

Stubble mulch. Stubble or other crop residue left on the soil, or partly worked into the soil, to provide protection from soil blowing and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Subsurface layer. Technically, the A2 horizon. General y refers to a leached horizon lighter in color and lower in content of organic matter than the overlying surface layer.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that it can soak into the soil or flow slowly to a prepared outlet without harm. A terrace in a field is generally built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea. A stream terrace is frequently called a second bottom, in contrast with a flood plain, and is seldom subject to overflow. A marine terrace, generally wide, was deposited by the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt, silt loam, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay.* The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine.'

Thin layer. Otherwise suitable soil material too thin for the specified use.

Till plain. An extensive flat to undulating area underlain by glacial till.

Tilth, soil. The condition of the soil, especially the soil structure, as related to the growth of plants. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Toe slope. The outermost inclined surface at the base of a hill; part of a foot slope.

Topsoil (engineering). Presumably a fertile soil or soil material, or one that responds to fertilization, ordinarily rich in organic matter, used to topdress roadbanks, lawns, and gardens.

Trace elements. The chemical elements in soils, in only extremely small amounts, essential to plant growth. Examples are zinc, cobalt, manganese, copper, and iron.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Unstable fill. Risk of caving or sloughing in banks of fill material.

Valley fill. In glaciated regions, material deposited in stream valleys by glacial melt water. In nonglaciated regions, alluvium deposited by heavily loaded streams emerging from hills or mountains and spreading sediments onto the lowland as a series of adjacent alluvial fans.

Variant, soil. A soil having properties sufficiently different from those of other known soils to justify a new series name, but the limited geographic soil area does not justify creation of a new series.

Variegation. Refers to patterns of contrasting colors assumed to be inherited from the parent material rather than to be the result of poor drainage.

Volcanic ash. Uncemented pyroclastic material consisting of fragments mostly under 4 mm in diameter.

Water table. The upper limit of the soil or underlying rock material that is wholly saturated with water.

Water table, apparent. A thick zone of free water in the soil. An apparent water table is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil.

Water table, artesian. A water table under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole.

Water table, perched. A water table standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decompositon of the material

Well graded. Refers to a soil or soil material consisting of particles well distributed over a wide range in size or diameter. Such a soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

Wilting point (or permanent wilting point). The moisture content of soil, on an ovendry basis, at which a plant (specifically sunflower) wilts so much that it does not recover when placed in a humid, dark chamber.

Illustrations

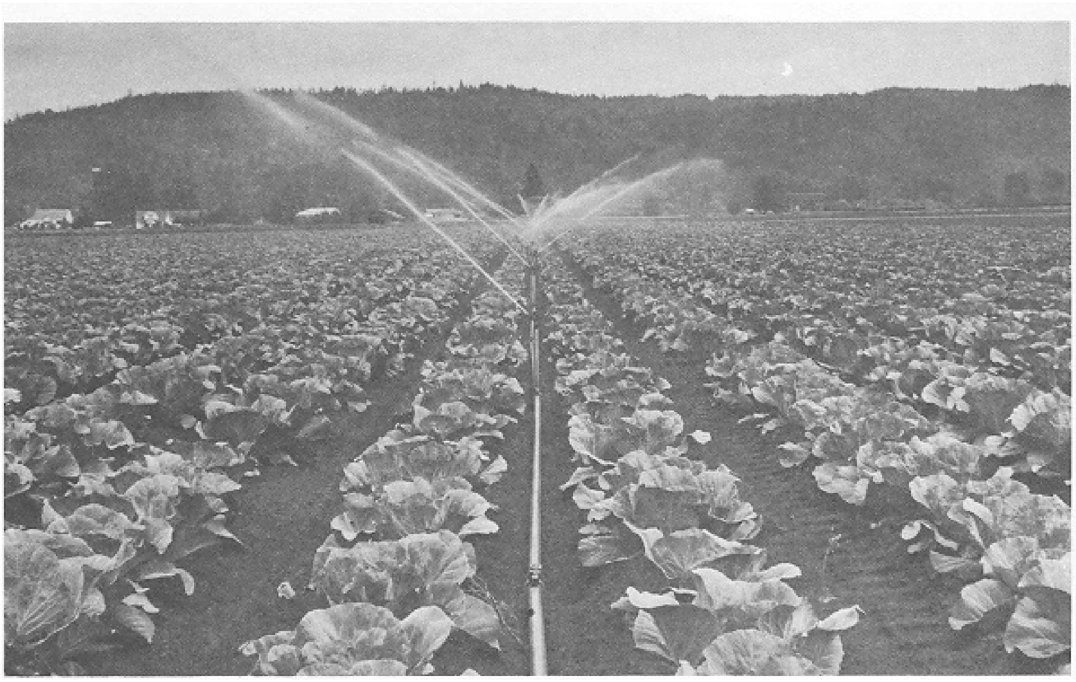

Figure 1.-Cabbage on Snohomish silty clay loam.

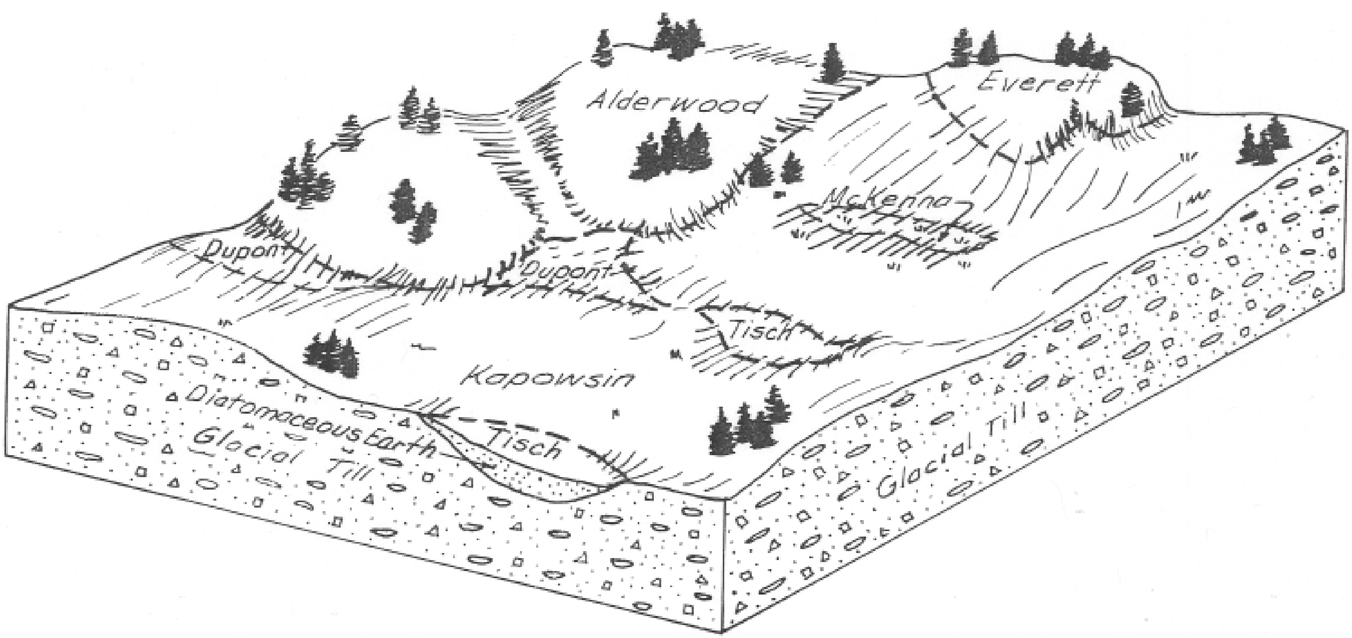

Figure 2.-Pattern of soils and parent material in the Kapowsin association.

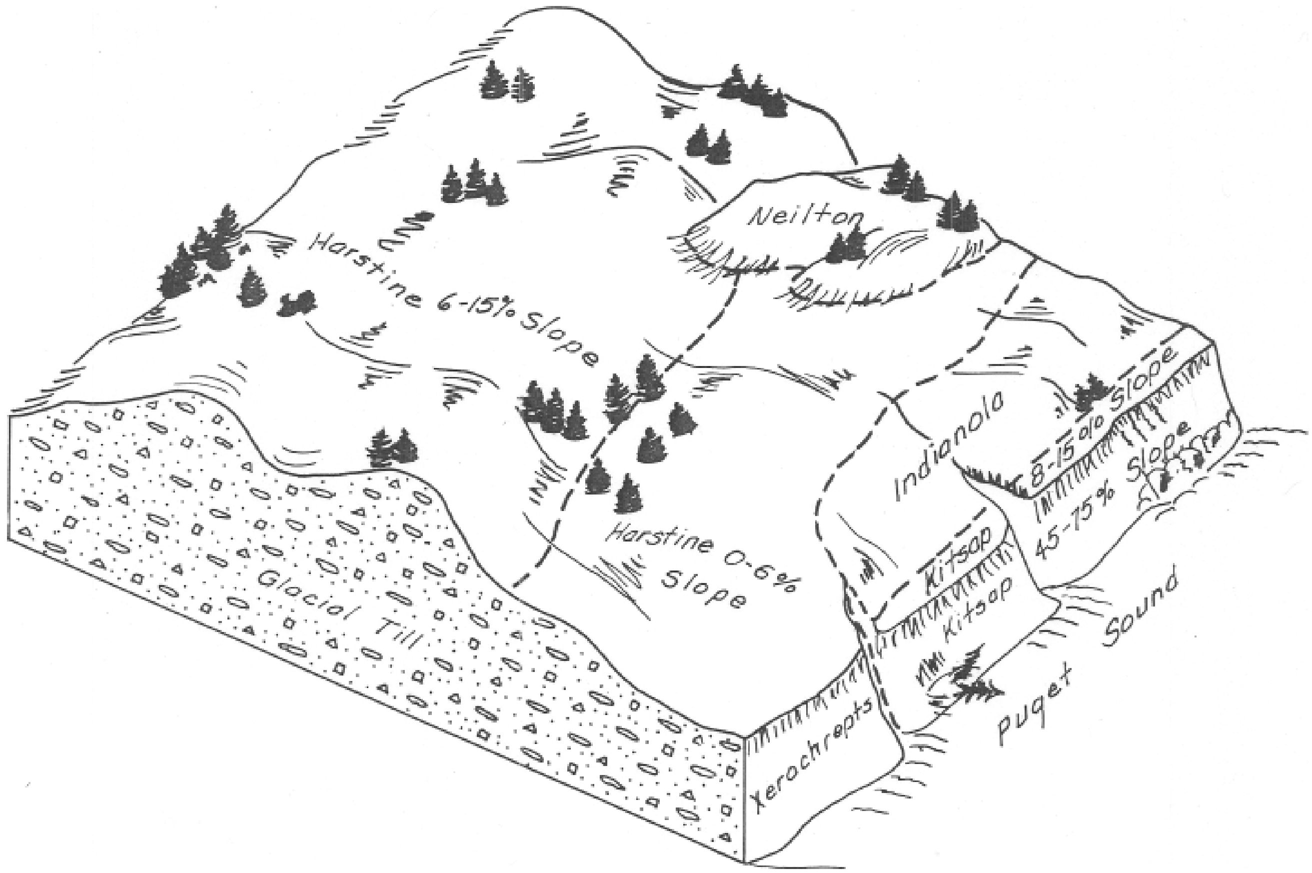

Figure 3-Pattern of soils and parent material in the Harstine association.

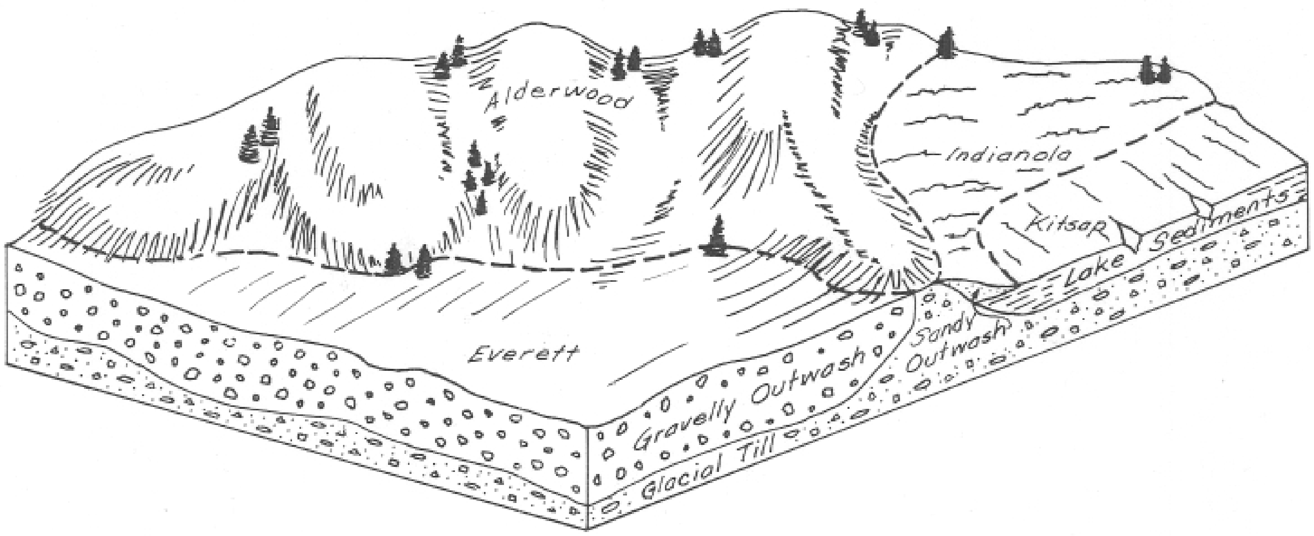

Figure 4.-Pattern of soils and parent material in the Alderwood-Everett association.

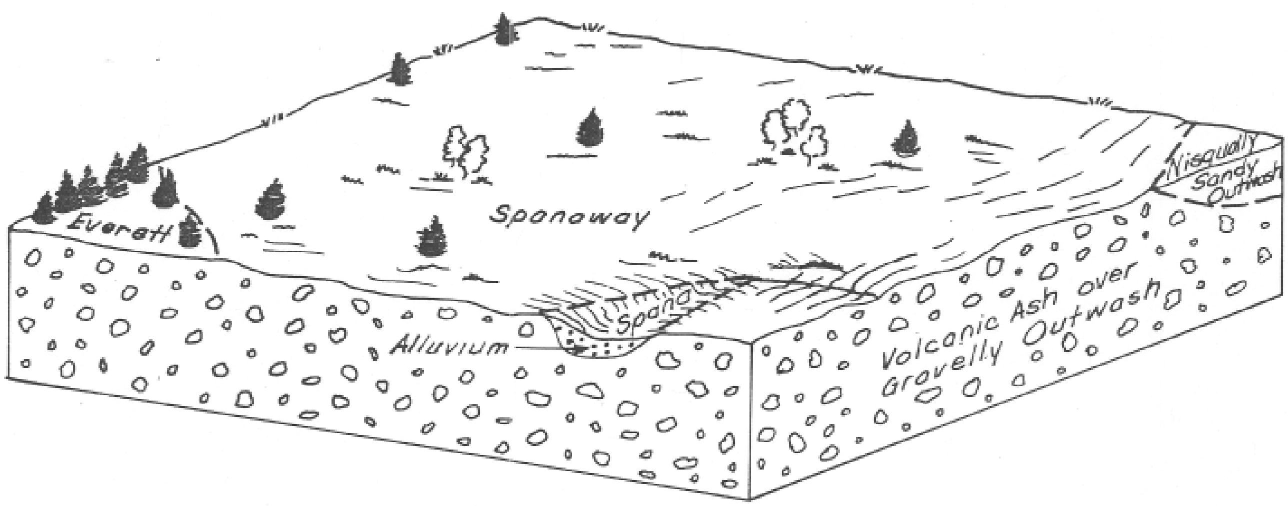

Figure 5.- Pattern of soils and parent material in the Spanaway association.

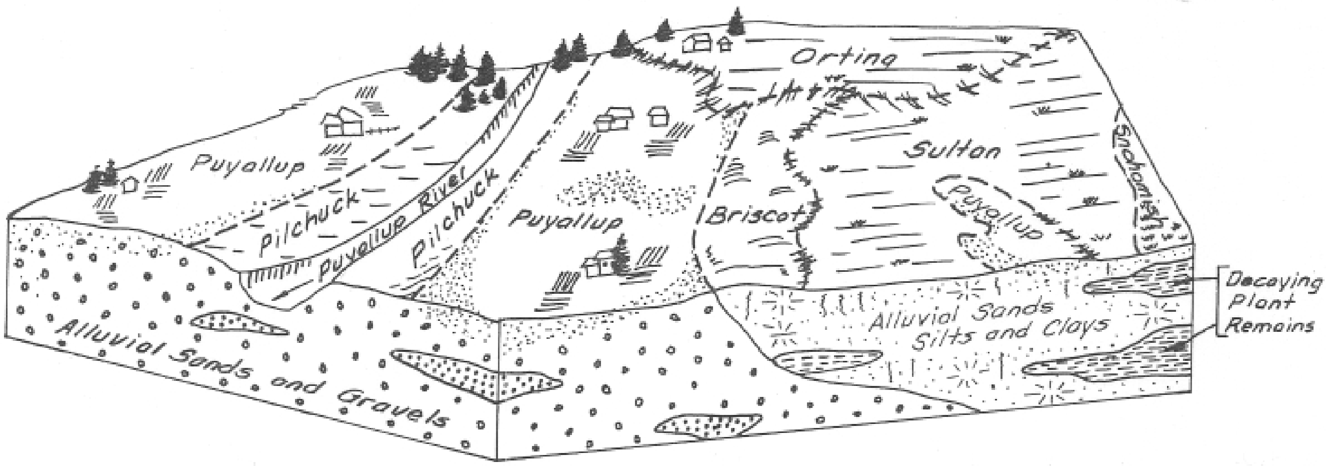

Figure 6.-Pattern of soils and parent material in the Puyallup-Sultan association.

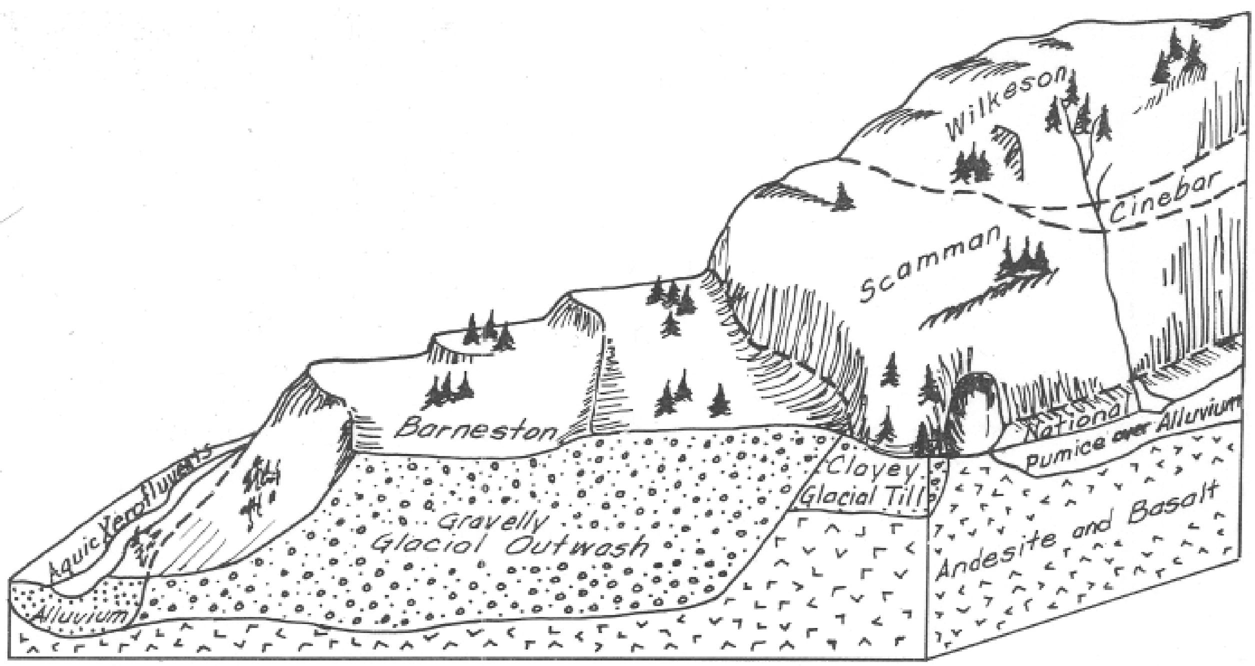

Figure 7.-Pattern of soils and parent material in the Barneston-Scammon-Wilkeson association.

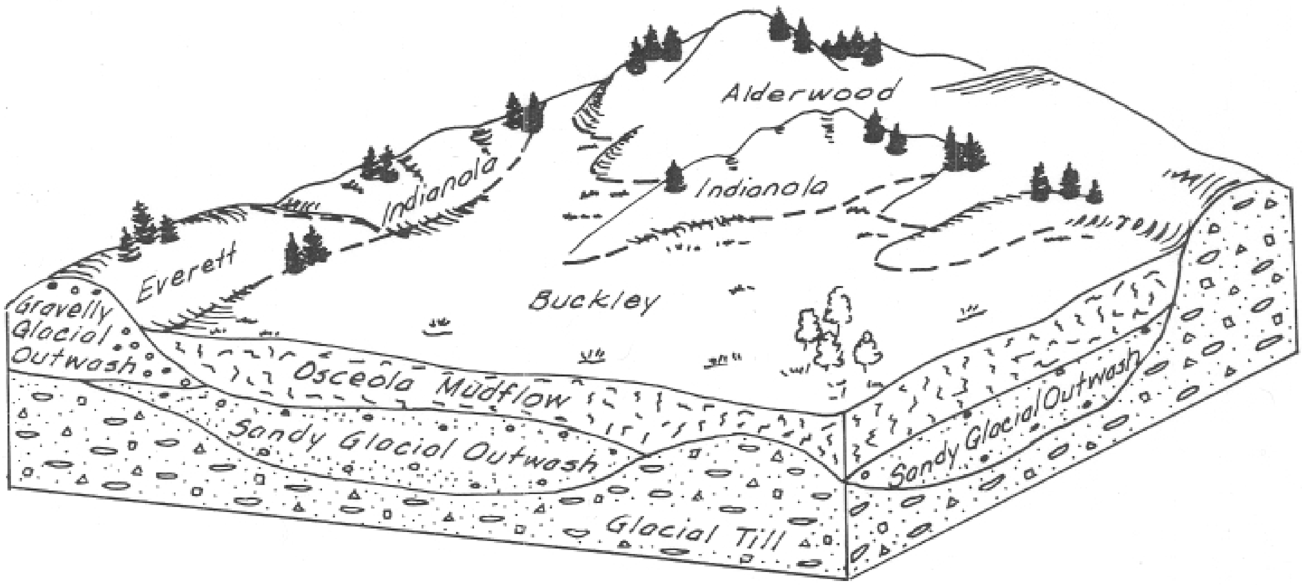

Figure 8.-Pattern of soils and parent material in the Buckley association.

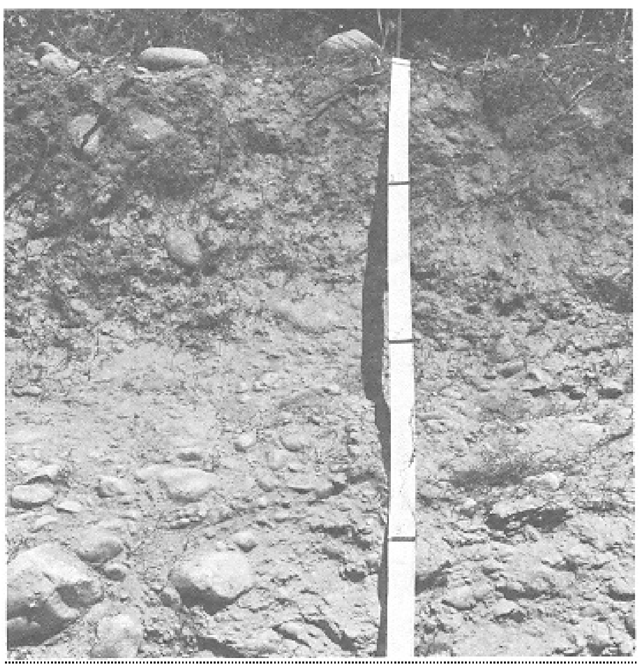

Figure 9.-Typical profile of Alderwood gravelly sandy loam. Most of the roots are above the compact substratum.

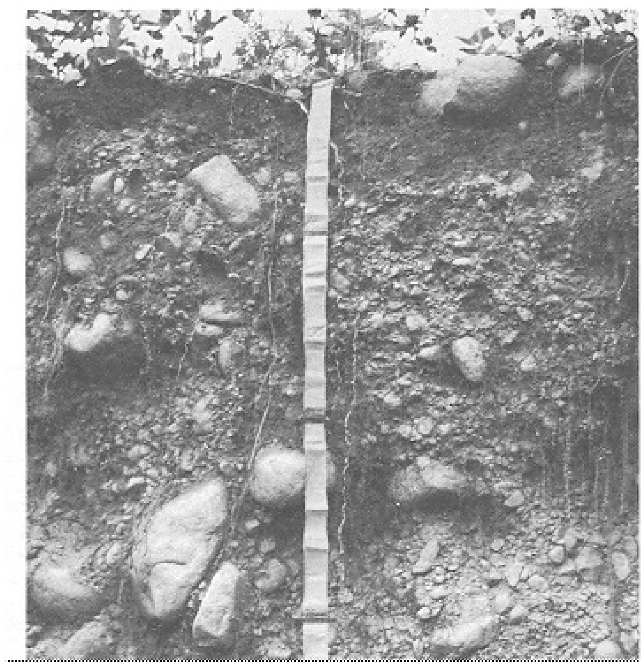

Figure 10.-Typical profile of Barneston gravelly coarse sandy loam.

Figure 11.-An area of Douglas-fir on Everett gravelly sandy loam, 0 to 6 percent slopes, being converted to urban use.

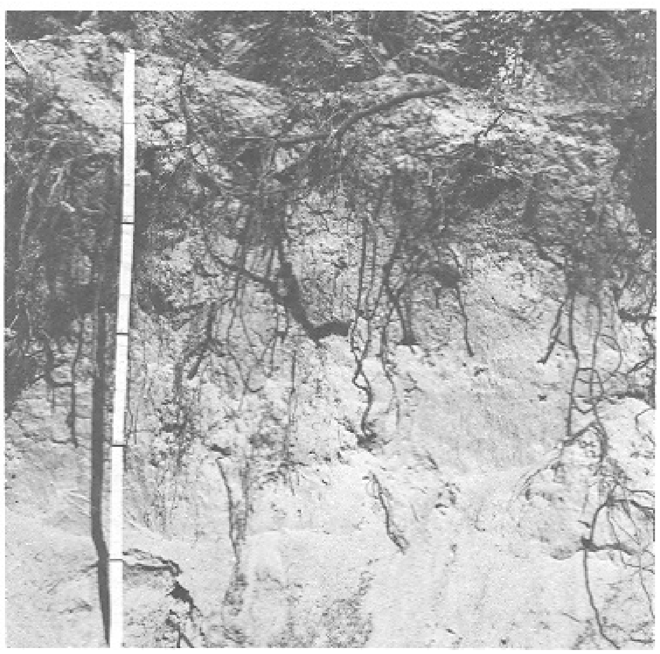

Figure 12.-Profile of Indianola loamy sand, 0 to 6 percent slopes.

Figure 13.-Hay and pasture on nearly level to undulating Kapowsin gravelly loam.

Figure 14.-Profile of Spanaway gravelly sandy loam.